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WAR MACHINE

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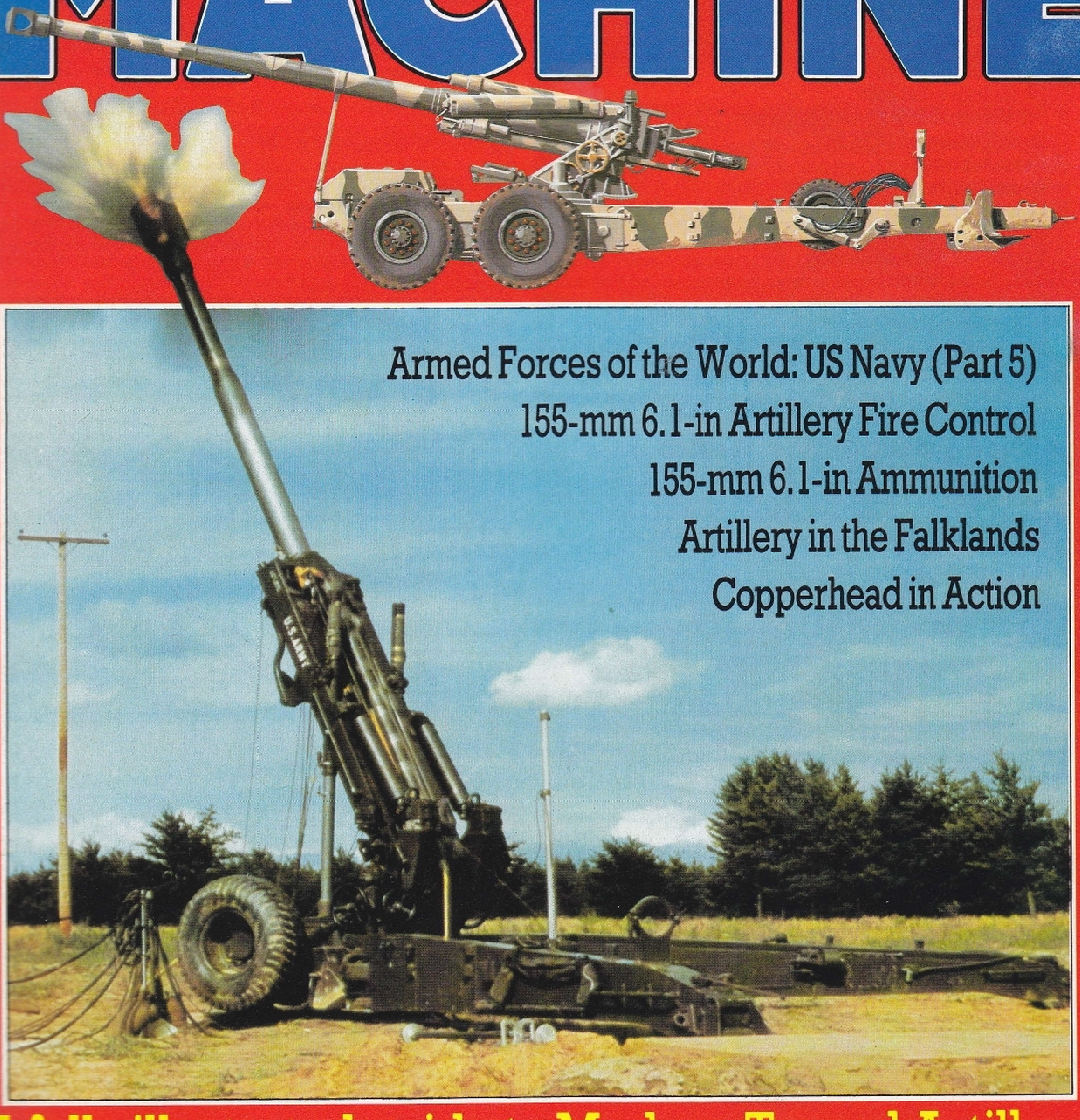

Armed Forces of the World: US Navy (Part 5)

155-mm 6.1-in Artillery Fire Control

155-mm 6.1-in Ammunition

Artillery in the Falklands

Copperhead in Action

A fully illustrated guide to Modern Towed Artillery

WAR MACHINE

Volume 4 **Issue 38**

CONTENTS

Modern Towed Artillery

CITEFA Model 77 155-mm howitzer 742
GHN-45 155-mm gun/howitzer 742
Modèle 50 155-mm howitzer 743
TR 155-mm gun 744
Soltam M-68 155-mm gun/howitzer 744
155-mm Artillery Fire Control 745
OTO Melara modello 56 105-mm pack howitzer 746
155-mm Field Howitzer 70 (FH-70) 747
155-mm Ammunition 748
105-mm Light Gun 748
Artillery in the Falklands 752
G5 155-mm gun/howitzer 754
Bofors FH-77A 155-mm field howitzer 754
M102 105-mm howitzer 755
Copperhead in Action 756
M198 155-mm howitzer 758
D-30 122-mm howitzer 758
M-46 130-mm field gun 759
S-23 180-mm gun 760
M-56 105-mm howitzer 760

Armed Forces of the World:

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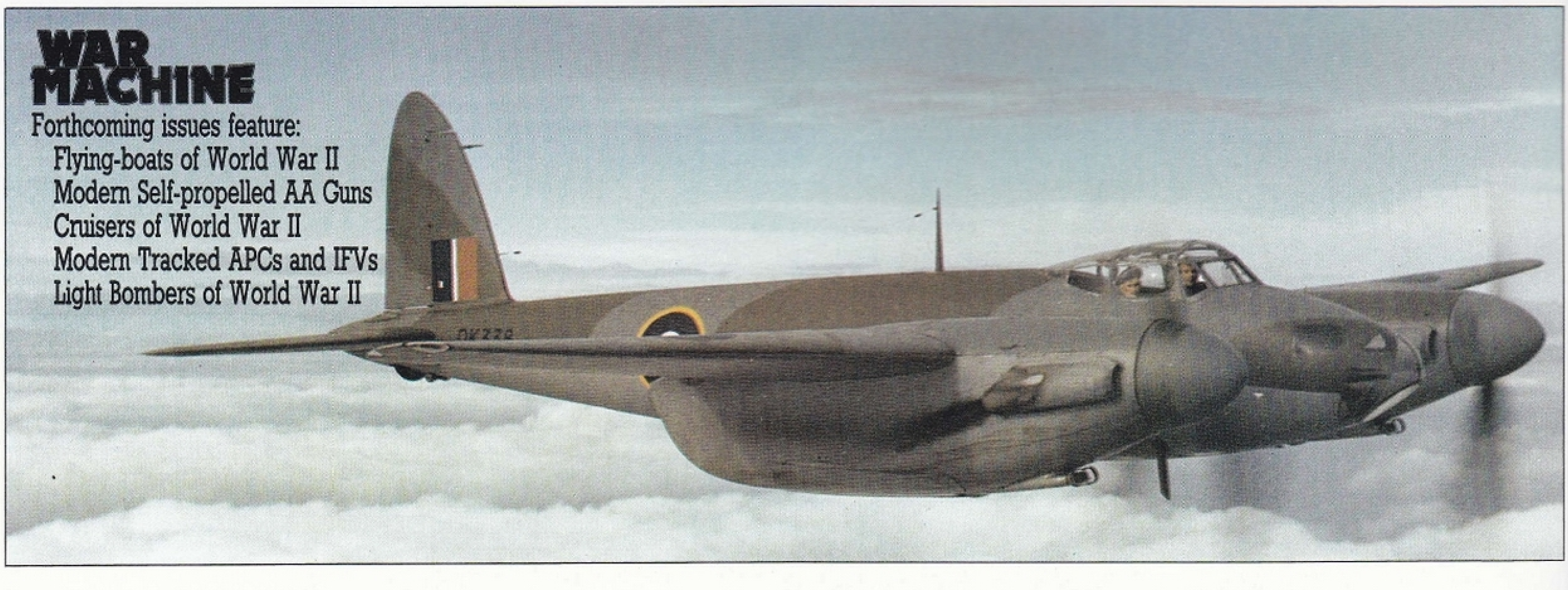

WAR MACHINE
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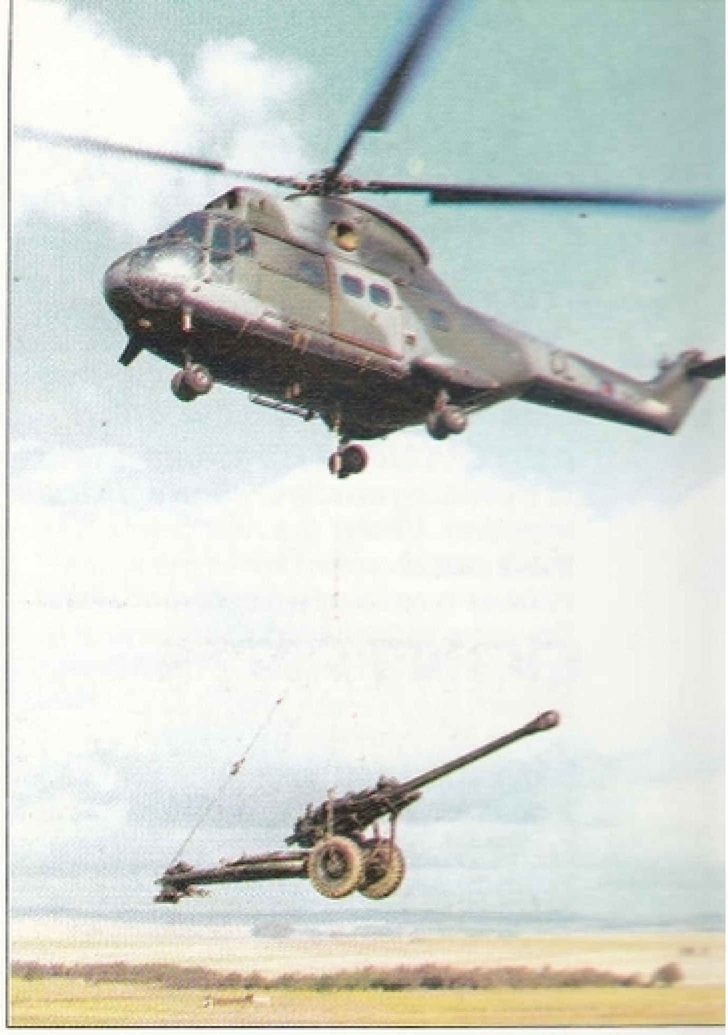
Modern Towed Artillery

Towed artillery has been superseded in many of the highly mechanized armies of the 1980s. In spite of this, development of the towed gun/howitzer has proceeded rapidly, and with good reason; recent conflicts such as Angola, Grenada and the Falklands have shown that there is still a need for 105-mm and 155-mm howitzers that can quickly be deployed from one area to another by aircraft or helicopter.



A Westland/Aérospatiale Puma helicopter of the Royal Air Force with a Royal Ordnance Factory Nottingham 105-mm (4.13-in) Light gun slung underneath. The 105-mm Light Gun was extensively used by the Royal Artillery in the Falklands campaign.

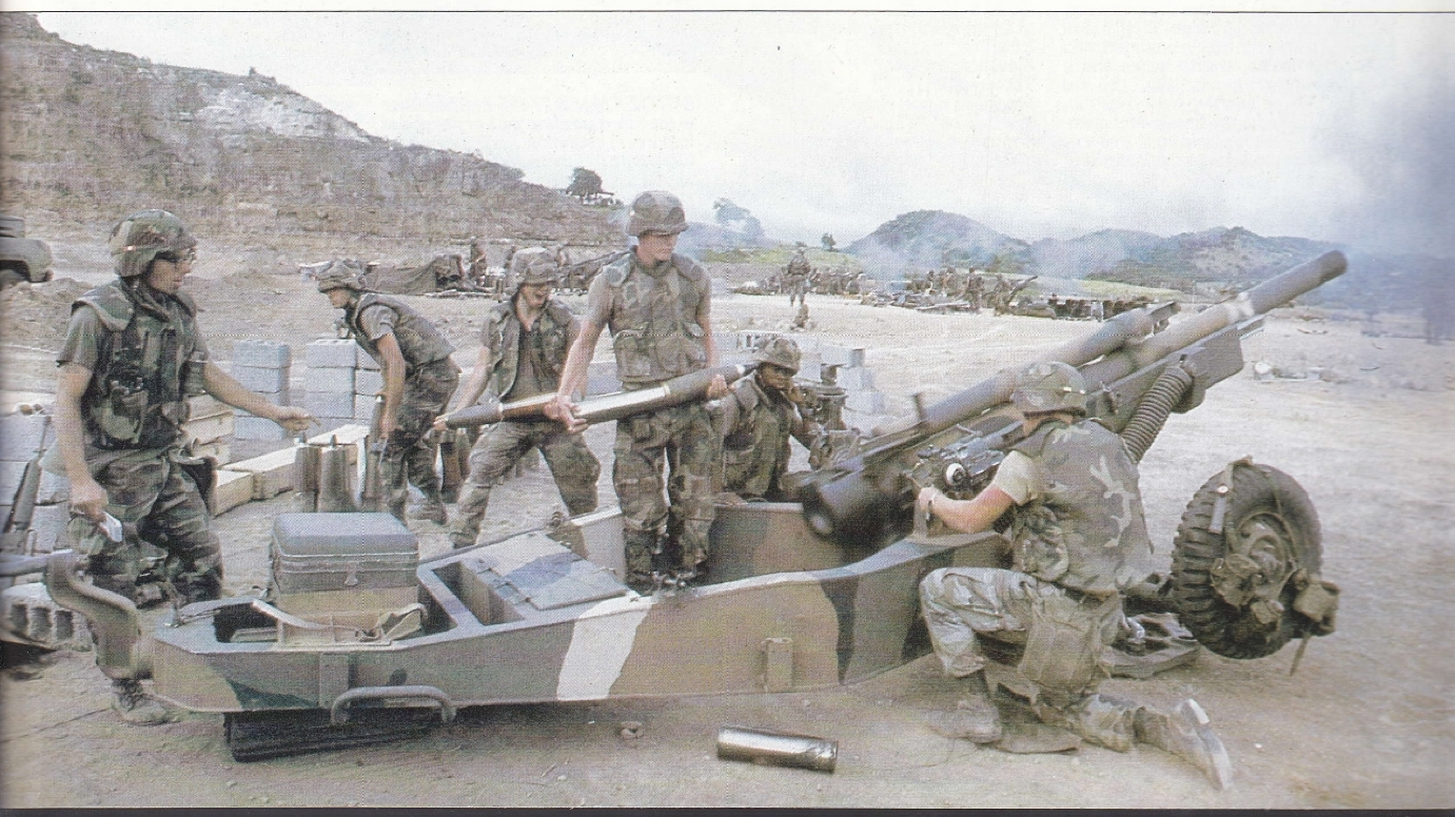
Although many European and Middle East armies have replaced much of their towed artillery with self-propelled guns and howitzers, the towed weapon still has an important part in most armies. While mechanized infantry and armoured divisions require tracked artillery weapons, as only these systems can keep up with the main formations while moving across country, there are still, even in the United States, a number of basic infantry divisions that rely on trucks to transport much of their personnel. For this type of unit, and for reserve units, towed 155-mm (6.1-in) systems such as the American M198, Swedish FH-77A, French TR and British/West German/Italian FH-70 have been developed and recently deployed. All but the M198 have an auxiliary power unit (APU) which enables the weapon to propel itself locally across country or around the battery position. The artillery piece with an APU is by no means a new concept, the Soviets having had the 85-mm (3.35-in) SD-44 auxiliary-propelled field gun in service for many years. In some cases the APU can also help to bring the weapon into action, as well as assisting with ammunition handling. Towed weapons are also much cheaper to procure, maintain and operate than their self-propelled counterparts.

In recent years a number of countries outside the major powers, such as Argentina, Austria, Israel and South Africa have developed 155-mm (6.1-in) artillery systems. Sometimes these weapons are based in part or whole on European designs, while in other cases the weapon and its associated ammunition is of wholly local design.

While most of the recent Western systems are of 155-mm (6.1-in) calibre, the British ROF Light Gun and the OTO Melara Model 56 pack howitzer, both in 105-mm (4.13-in) calibre, are still in production and widely used for airborne, commando, marine and alpine units, the 155-mm (6.1-in) systems often being too heavy for deployment in the terrain encountered by such units. Although the Model 56 has a short range by modern standards, it is one of the few weapons that can be dismantled for transportation by pack animal across mountainous terrain.

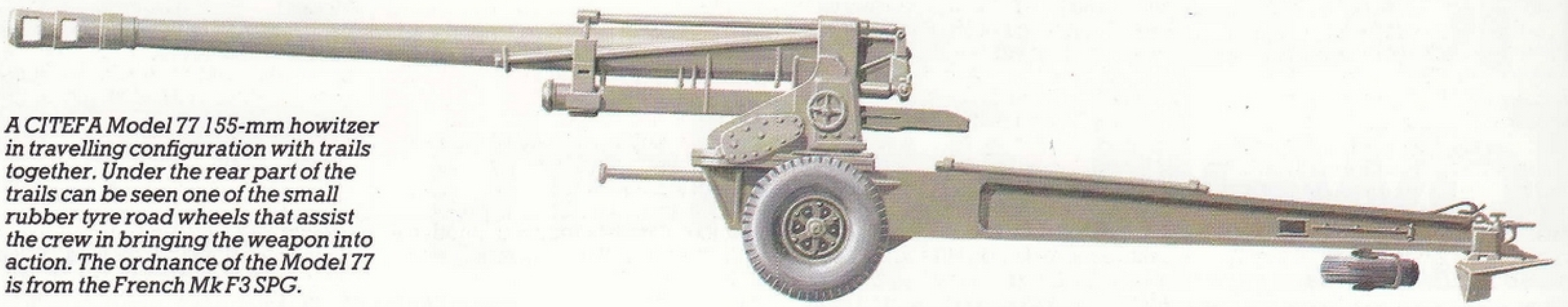
It should not be forgotten that the gun or howitzer is only part of the weapon system, as the whole object of the weapon is to put the ammunition onto the target so as to cause the maximum possible amount of damage. To achieve this end, the ammunition must be effective, the crew well trained, an adequate towing vehicle supplied and, of course, a fire-control system employed.

American field artillery gunners prepare to load their 105-mm (4.1-in) M102 light howitzer during operations in Grenada in 1983. The M102 was originally developed in response to an urgent need in Vietnam, and has replaced the M101 in the US Army, equipping in particular the artillery units of the 82nd Airborne Division and the 101st Air Assault Division.



ARGENTINA

CITEFA Model 77 155-mm howitzer



A CITEFA Model 77 155-mm howitzer in travelling configuration with trails together. Under the rear part of the trails can be seen one of the small rubber tyre road wheels that assist the crew in bringing the weapon into action. The ordnance of the Model 77 is from the French Mk F3 SPG.

Some years ago Argentina purchased a number of members of the AMX-13 family of light tracked vehicles from France as well as undertaking the assembly of a quantity of vehicles. These included the AMX-13 light tank with a 90-mm (3.54-in) gun, the AMX VCI armoured personnel carrier, and the 155-mm (6.1-in) Mk F3 self-propelled gun. At that time the standard 155-mm (6.1-in) towed howitzer of the Argentine army was the American M114, which dated back to World War II and had a maximum range of 14600 m (15,965 yards). To replace the M114 the Instituto de Investigaciones Cientificas y Tecnicas de las Fuerzas Armadas (CITEFA) designed a new bottom carriage that would take the complete top carriage (barrel, cradle, recoil system and equilibrators) of the Mk F3 self-propelled gun. After trials this was accepted for service with the Argentine army under the designation **155-mm Howitzer L33 X1415 CITEFA Model 77**, L33 referring to the length of the ordnance in calibres and Model 77 to the year of acceptance. A later model, the **Model 81**, differs in minor details and also has a barrel of Argentine rather than French manufacture. Together with the OTO Melara 105-mm (4.13-in) Model 56 pack howitzer the Model 77 was deployed to the Falklands, and all of these equipments were subsequently captured by the British, some of them being shipped to the UK for trial and display purposes.

The barrel of the Model 77 is 5.115 m (16 ft 9.4 in) long, and is provided with a double-baffle muzzle brake and a screw breech mechanism. The top carriage is of welded steel construction and contains the traverse mechanism and elevating brackets. The former is mounted inside the lower part and forming the connection with the cradle trunnion attachment and the bottom carriage. The bottom carriage is of the split-trail type, and is also of welded construction. Each trail leg is provided with a small rubber-tyred road wheel to assist in bringing the weapon into and out of action, and at the end of each trail is a spade. When the equipment is in the firing position the carriage wheels are raised clear of the ground, support then being provided by a circular steel base attached to the carriage by a ball socket; the latter feature helps to compensate for rough ground. When the equipment is being towed, the support is raised, giving ground clearance of 0.3 m (12 in). Maximum rate of fire is four rounds per minute, and sustained rate one round per minute. The equipment fires an HE projectile weighing 43 kg (94.8 lb) with a maximum muzzle velocity of 765 m (2,510 ft) per second to a maximum range of 22000 m (24,060 yards); there are also illuminating and smoke projectiles. According to the manufacturer a rocket-assisted projectile is available, but as far as is known such a projectile was not used in the Falklands campaign.

Specification

Model 77 howitzer

Calibre: 155 mm (6.1 in)

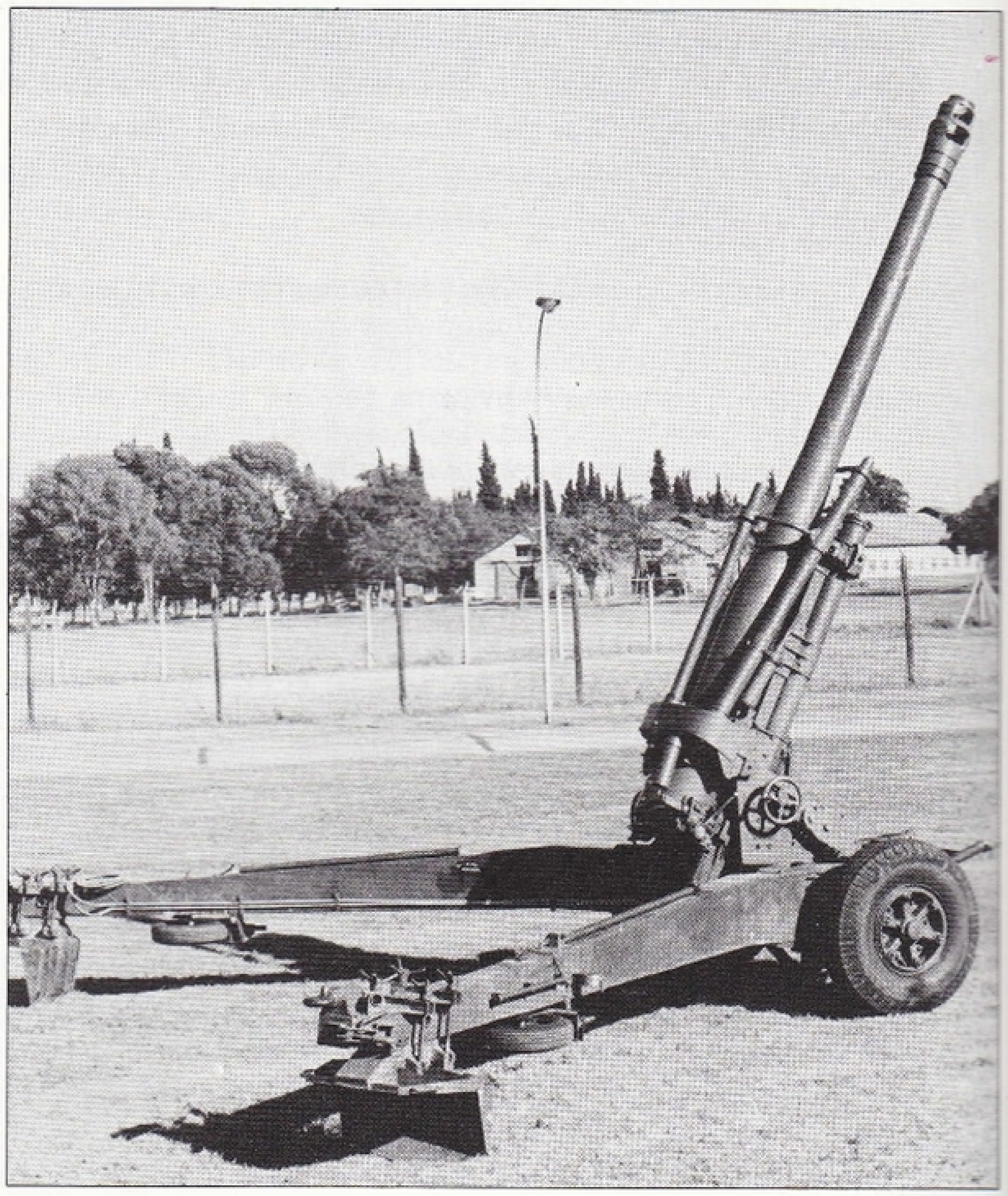
Weight: travelling 8000 kg (17,637 lb)

Dimensions: length, travelling 10.15 m (33 ft 3.6 in); width, travelling 2.67 m (8 ft 9 in); height, travelling 2.20 m (7 ft 2.6 in)

Elevation: +67°/−0°

Traverse: total 70°

Maximum range: with normal ammunition 22000 m (24,060 yards) and with rocket-assisted projectile 23300 m (25,480 yards)

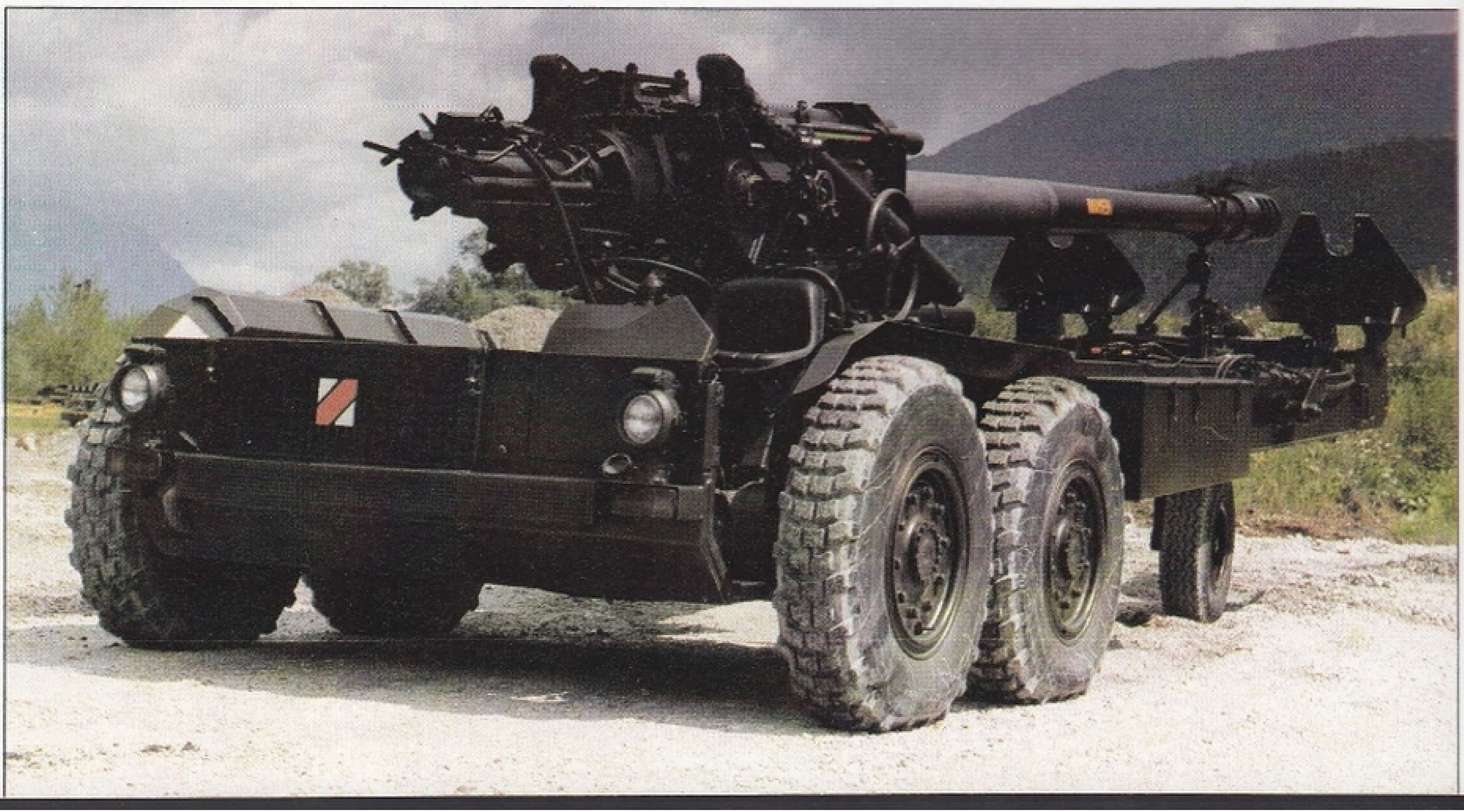


A CITEFA Model 77 155-mm howitzer in the firing position with ordnance at maximum elevation. Each trail is fitted with its spade, but as the weapon has yet to be fired they are not bedded in. The Model 77 was used against the British forces during the 1982 Falklands campaign.

AUSTRIA

GHN-45 155-mm gun/howitzer

In the 1970s PRB of Belgium, a well-known manufacturer of ammunition, and Space Research Corporation of Canada jointly established a company called SRC International with its headquarters in Brussels. This company developed a gun howitzer called the **GC 45**, of which 12 were subsequently ordered by the Royal Thai Marines, as well as a conversion kit for the standard 155-mm (6.1-in) M114 howitzer. The first two weapons were built in Canada while the remaining 10 were built in Canada but assembled in Austria by Voest-Alpine. Further de-



A Voest-Alpine GHN-45 155-mm gun/ howitzer in the travelling position with ordnance locked over trails. This Austrian-produced weapon is in service with the Jordanian army, and some may have found their way to Iraq and seen recent use.

velopment by Voest-Alpine resulted in the **GHN-45** 155-mm (6.1-in) gun/howitzer, of which 200 were ordered by Jordan. Production of these weapons started in 1981, the first weapons being delivered during the following year. Unconfirmed reports have indicated that some of these weapons have already been transferred from Jordan to Iraq and used against Iran. The original weapons supplied to Thailand have been used in action on the Thai border against Kampuchea.

The basic version of the GHN-45 is normally towed by a standard 10-tonne (6×6) truck if required. More recently a model fitted with an auxiliary power unit on the front of the carriage has been developed. This enables the weapon to propel itself on roads at a maximum speed of 35 km/h (22 mph), and the 80-litre (17.6-Imp gal) fuel tank provides a range of 150 km (93 miles). In normal practice the system is moved from one firing position to another by a truck with the ordnance traversed over the trails and locked in position to reduce its overall length, the APU then being used for final positioning and for bringing the weapon into and out of action more quickly.

The GHN-45 has a standard 45-calibre barrel fitted with a triple-baffle muzzle brake, and can fire a standard US M107 high explosive projectile to a maximum range of 17800 m (19,465 yards) or an M101 projectile to a maximum range of 24000 m (26,245 yards). With the Extended-Range Full Bore (ERFB) projectile manufactured by PRB, a range of 30000 m (32,810 yards) can be achieved, while the ERFB projectile with base bleed goes out to 39000 m (42,650 yards). With such long ranges, however, target-acquisition and projectile dispersion are major problems.

The ERFB projectile, developed from the earlier extended-range subbore and extended-range sub-calibre projectiles, is longer and more streamlined than a conventional projectile, and therefore has reduced aerodynamic drag and thus increased range. The ERFB base bleed is the basic projectile with a different boat tail containing the base bleed unit, which reduces drag at the rear of the projectile, which thus decelerates more slowly, so increasing range. The basic HE ERFB projectile weighs 45.54 kg (100.4 lb), of which 8.62 kg (19 lb) is the Composition B explosive. Other projectiles include smoke, illuminating, smoke base-ejection and a cargo round which carries 13 kg (28.7 lb) of M42 grenades, which would be highly effective against vehicles and personnel.

Specification
GHN-45 gun/howitzer
Calibre: 155 mm (6.1 in)
Weight: 8900 kg (19,621 lb)
Dimensions: length, travelling 9.068 m (29 ft 9 in); width, travelling 2.48 m (8 ft 1.6 in); height, travelling 2.089 m (6 ft 10.25 in)
Elevation: +72°/−5°
Traverse: total 70°
Maximum range: with ERFB ammunition 30000 m (32,810 yards) and with base-bleed ammunition 39000 m (42,650 yards)

FRANCE

Modèle 50 155-mm howitzer

For the last 30 years the **modèle 50** 155-mm (6.1-in) howitzer has been the standard towed howitzer of the French army, and has also been made under licence by Bofors of Sweden for the Swedish army under the designation **15.5-cm Field Howitzer Fr.** In the French army it will soon be replaced by the new 155-mm (6.1-in) TR towed gun, which has an integral auxiliary power unit and a much longer range, while in the Swedish army it is being replaced by the Bofors 155-mm (6.1-in) FH-77A. The modèle 50 howitzer, which is also called the **OB-155-50 BF** by the French army, was also exported to the Lebanon (where some were captured from the PLO during the fighting of the summer of 1982), Israel, Switzerland and Morocco.

The barrel of the modèle 50 is 4.41 (14 ft 5.6 in) long, and has an unusual multi-baffle muzzle brake, hydropneumatic recoil system that varies with elevation, and a screw breech mechanism. The carriage is of the split-trail type with two rubber-tyred road wheels located on each side of the forward part of the carriage. When being towed by a truck the ordnance is locked to the trails by a locking device which is situated in the rear part of the cradle. To enable the equipment to be towed at high speeds on roads, the modèle 50 has a brake system operated by compressed air from the towing vehicle.

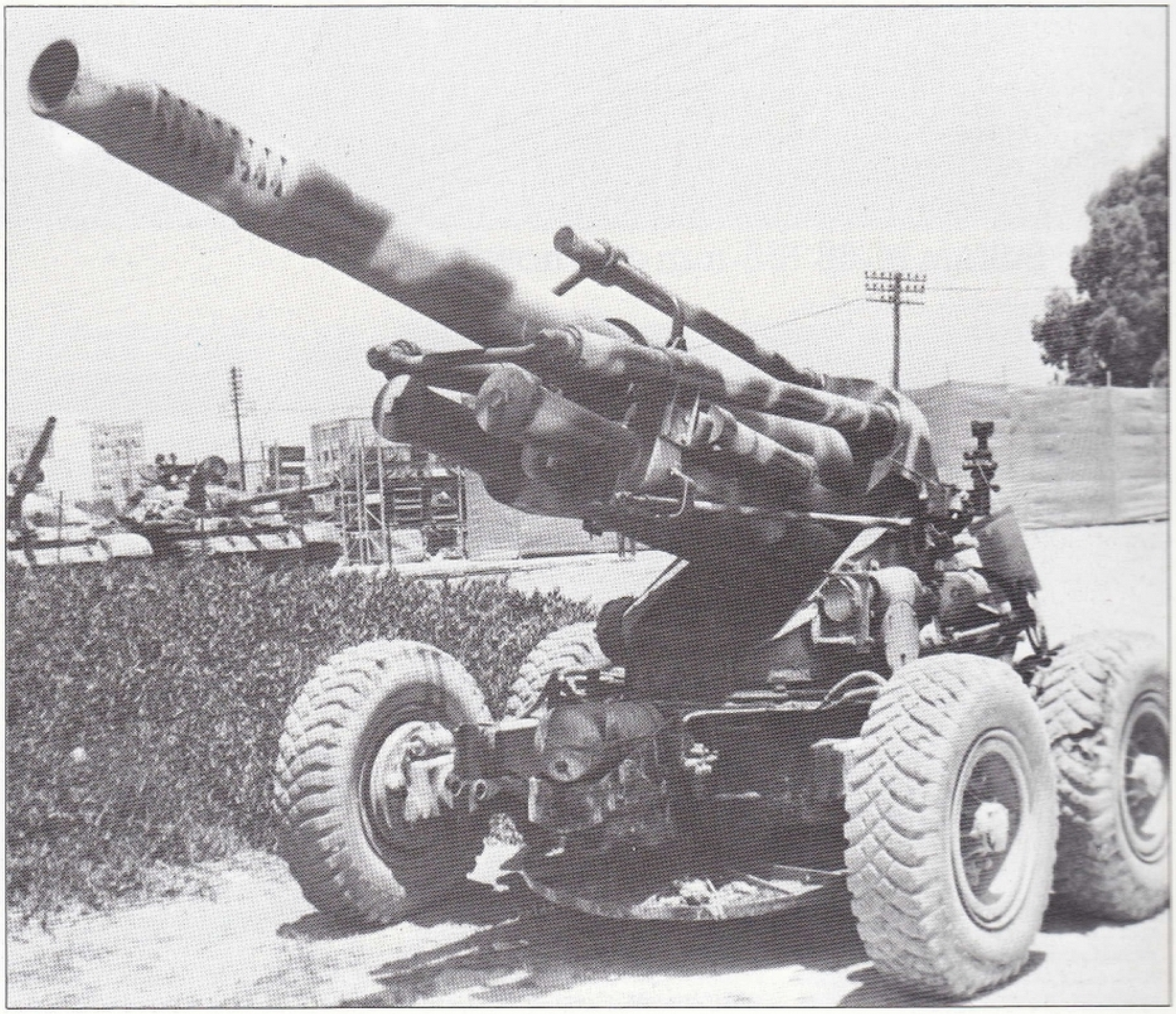
When in the firing position the forward part of the carriage is supported by a circular pivot plate underneath and by the ends of each trail.

The modèle 50 is operated by an 11-man crew, and in the French army is normally towed by a Berliet GBU 15 (6+6) truck, which also carries the crew and ammunition. Ammunition is of the separate-loading type, the HE projectile weighing 43 kg (94.8 lb) and having a maximum muzzle velocity of 650 m (2,135 ft) per scond to give a range of 18000 m (19,685 yards). Illuminating and smoke projectiles can also be fired. More recently Brandt has developed a rocket-assisted HE projectile with a maximum range of 23300 m (25,480 yards). Maximum rate of fire is between three and four rounds per minute.

To meet the requirements of the Israeli army, the French Etablissement d'Etudes et Fabrications d'Armement de Bourges fitted the modèle 50 howitzer to a much modified Sherman chassis, and this entered service with the Israeli army in 1963 as the 155-mm (6.1-in) self-propelled howitzer **Model 50** (or **M-50**). The modifications to the chassis were extensive, and included moving the engine to the front of the vehicle on the right side with the driver being located to its left. The 155-mm (6.1-in) howitzer is mounted at the rear of the hull in an open-topped compartment, over which a tarpaulin cover can be fitted in wet weather. Stowage boxes are provided externally above the tracks. When the vehicle is in the firing position the rear of the hull folds down and doors open on each side to reveal ammunition stowage. Loaded weight of the M-50 is 31 tonnes, and the crew consists of eight men including the driver. Several of these systems were captured by the Egyptians in the heavy fighting around Suez in the 1973 Middle East War.

Specification
modèle 50 howitzer
Calibre: 155 m (6.1 in)
Weight: travelling 9000 kg (19,841 lb) and firing 8100 kg (17,857 lb)
Dimensions: length, travelling 7.80 m (25 ft 7.1 in); width, travelling 2.75 m (9 ft 0 in); height, travelling 2.50 m (8 ft 2.4 in)
Elevation: +69°/−4°
Traverse: total 80°
Maximum range: with standard round 18000 m (19,685 yards) and with rocket-assisted projectile 23300 m (25,480 yards)

This Modèle 50 155-mm howitzer, captured by the Israeli army during the 1982 invasion of Lebanon, clearly shows the turntable in the raised position under the carriage. The weapon is still used by France, Morocco, Sweden and Switzerland.



FRANCE

TR 155-mm gun

While the United Kingdom, Italy and West Germany elected to develop a 155-mm (6.1-in) towed howitzer first (FH-70) and then a self-propelled model (SP-70), France decided to do the reverse. The 155-mm (6.1-in) GCT self-propelled gun on an AMX-30 MBT chassis entered production for Saudi Arabia in 1977, first production vehicles being completed during the following year, but the type was not formally adopted by the French army until 1979. Since then it has also been ordered by Iraq.

The prototype of the **TR** 155-mm (6.1-in) towed gun was shown for the first time at Satory in 1979 and following trials with eight prototypes production is expected to start in 1984. The French army has a requirement for 180 systems to replace the older towed 155-mm (6.1) modèle 50 howitzer.

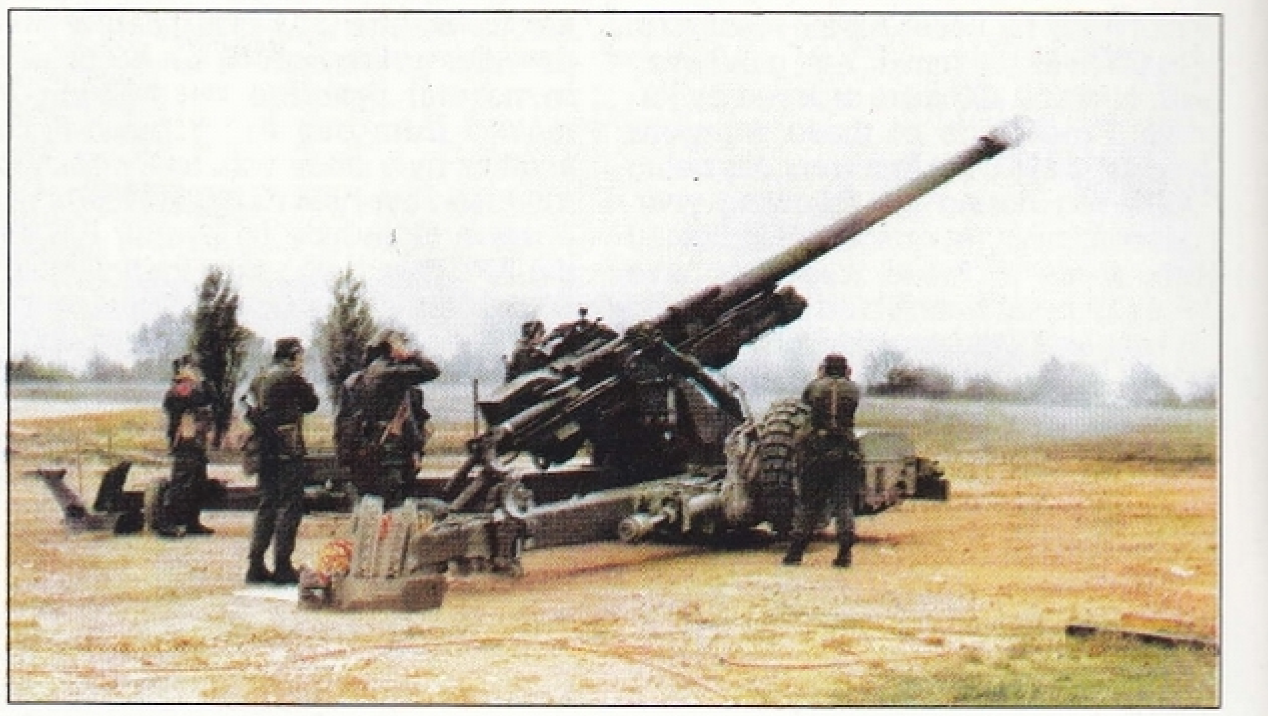
The TR towed gun has a barrel 6.20 m (20 ft 4.1 in) long, a double-baffle muzzle brake, a hydropneumatic recoil system and horizontal-wedge breech mechanism. The carriage is of the split trail type, with an auxiliary power unit located on the forward part. The 39-hp (29-kW) engine drives three hydraulic pumps, one for each of the main road wheels and the third to provide power for elevation, traverse, raising the suspension, trail wheel jacks and projectile-loading mechanism. The APU enables the weapon to propel itself around the battery position or on the road at a maximum speed of 8 km/h (5 mph). When being towed or travelling under its own power, the TR has its barrel traversed 180° and locked in position over the closed trails. The projectile-loading system makes possible firing rates of three rounds in the first 18 seconds, six rounds per minute for the first two minutes, and 120 rounds per hour thereafter. On any future battlefield in Europe such a weapon would have to be redeployed in a very short time as its position would soon be determined by the enemy, resulting in counterbattery fire.

The TR can fire several types of ammunition: the older modèle 56/59 HE projectile to a range of 19250 m (21,050 yards), the more recent Cr TA 68 HE projectile weighing 43.2 kg (95.25 lb) to a range of 24000 m (26,245 yards), the 155-mm (6.1-in) illuminating projectile (providing 800000 candelas of light) to a range of 21500 m (22,515 yards), a smoke incendiary projectile to a range of 21300 m (23,295 yards), and a Brandt rocket-assisted projectile to a range of 30500 m (33,355 yards). GIAT has recently announced that it is developing three new projectiles for the TR and GCT. The first of these is the so-called cargo round, which carries six anti-tank mines dispensed over the target; each of these weighs 0.55 kg (1.2 lb) and will penetrate 50 mm (1.47 in) of armour steel. The HE base-bleed round is called the HE BB, has a maximum range of 29500 m (32,260 yards) and weighs 43.5 kg (95.9 lb) of which 10 kg (22.05 lb) is high explosive. The last is the rocket-assisted projectile, which has a range of 33000 m (36,090 yards).

The TR has an eight-man crew, and will be towed by the new TRM 10 000 (6×6) 10-tonne truck, which also carries 48 projectiles, charges and fuses.

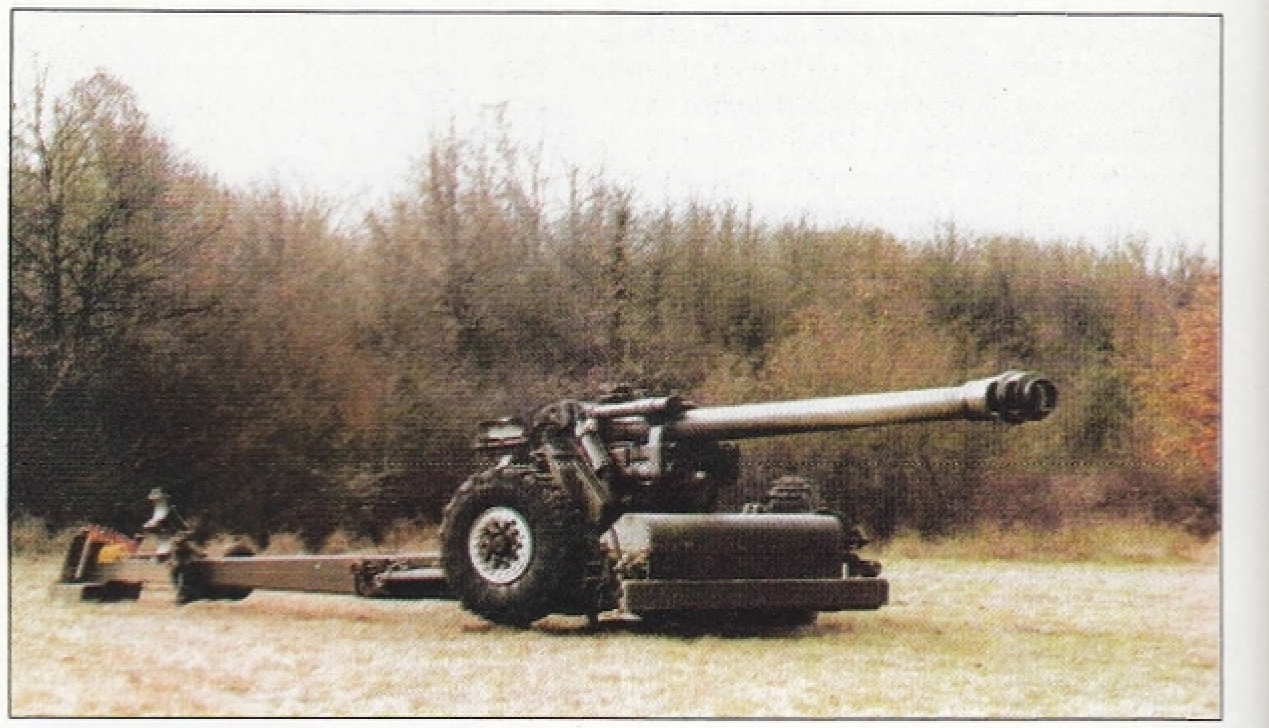
Specification

TR gun
Calibre: 155 mm (6.1 in)
Weight: travelling and firing 10650 kg (23,479 lb)
Dimensions: length, travelling 8.25 m (27 ft 0.8 in); width, travelling 3.09 m (10 ft 1.65 in); height, firing 1.65 m (5 ft 5 in)
Elevation: +65°/−5°
Traverse: total 65°
Maximum range: with standard projectile 24000 m (26,245 yards) and with rocket-assisted projectile 33000 m (36,090 yards)



Above: One of the prototypes of the new French TR 155-mm gun in the firing position. The French army is to take delivery of 180 of these systems to replace the 155-mm Modèle 50 howitzer, which has been in service for some 30 years. Like most modern weapons of this type it is fitted with an auxiliary power unit.

Below: A TR 155-mm gun from the front, showing the auxiliary power unit on the front of the carriage. This not only provides the power required to propel the weapon around on its own, but also to bring the weapon into and out of action as well as running the projectile loading mechanism.

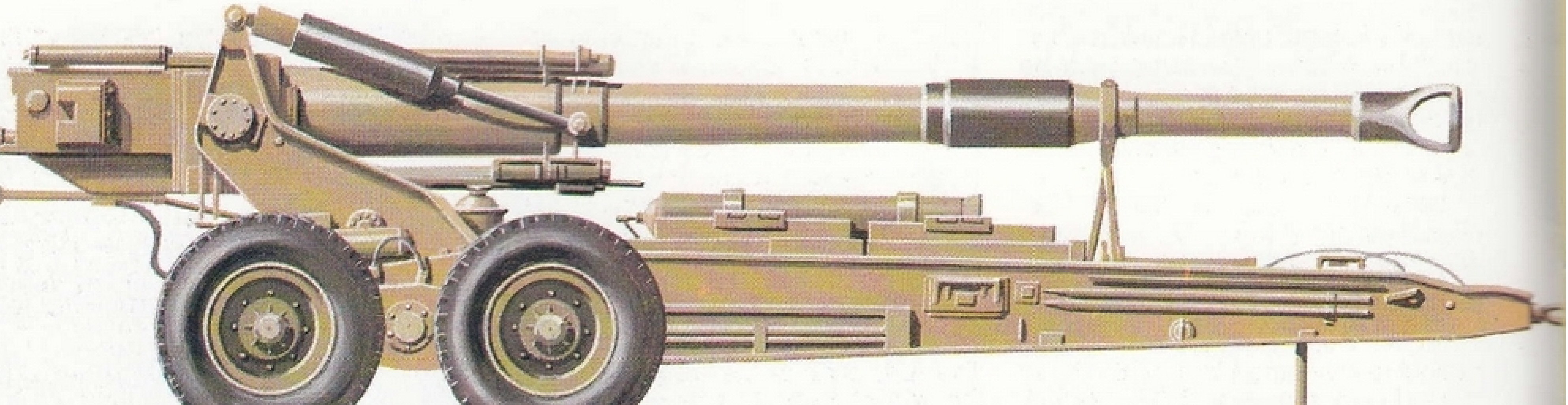


ISRAEL

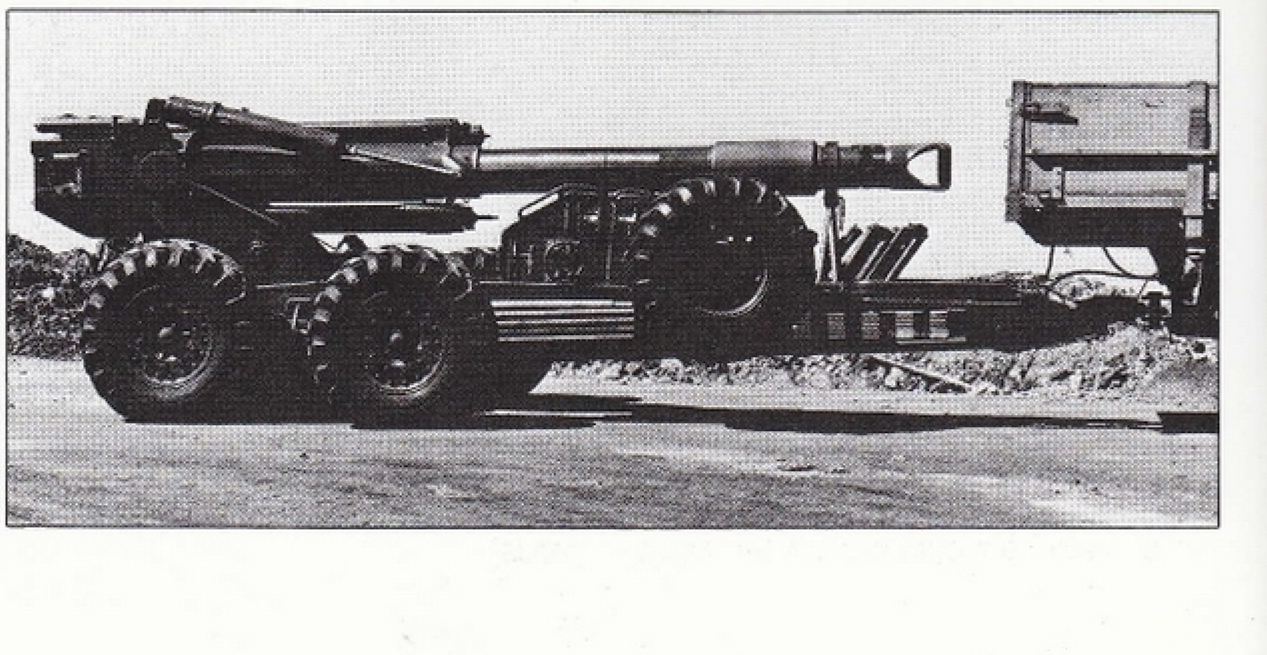
Soltam M-68 155-mm gun/howitzer

The only manufacturer of towed artillery in Israel is Soltam, which is believed to have close links with the Finnish company Tampella. The Soltam **M-68** 155-mm (6.1-in) gun/howitzer was developed as a private venture in the late 1960s, the first prototype being completed in 1968 and the first production models following two years later. As far as is known, the towed model is used only by Singapore and the Thai Marines, although the Soltam L-33 self-propelled gun/howitzer uses the ordnance, elevation and traverse system of the M-68. This entered service with the Israeli army in time to take part in the 1973 Middle East campaign.

The ordnance of the M-68 is 5.18 m (17 ft 0 in) long and fitted with a single-baffle muzzle brake, fume extractor and a horizontal breech mechanism. The recoil system is below the barrel and the counter recoil system above, the pneumatic equilibrators being located on side of the barrel. When travelling, the top carriage is traversed to the rear so that the ordnance is over the closed trails. The carriage is of the split-trail type. Two rubber-tyred road wheels are mounted on a bogie on each side; each wheel is fitted with a hydraulic brake, and a maximum tow-



Above: The Soltam M-68 155-mm gun/howitzer in the travelling position with ordnance traversed to rear and locked in position over trails. The Israeli army uses this weapon mounted on a rebuilt Sherman tank chassis in the self-propelled role.



Right: The Soltam M-68 155-mm gun/howitzer in travelling configuration, being towed by a truck. More recently the company has developed a new long-barrelled howitzer.

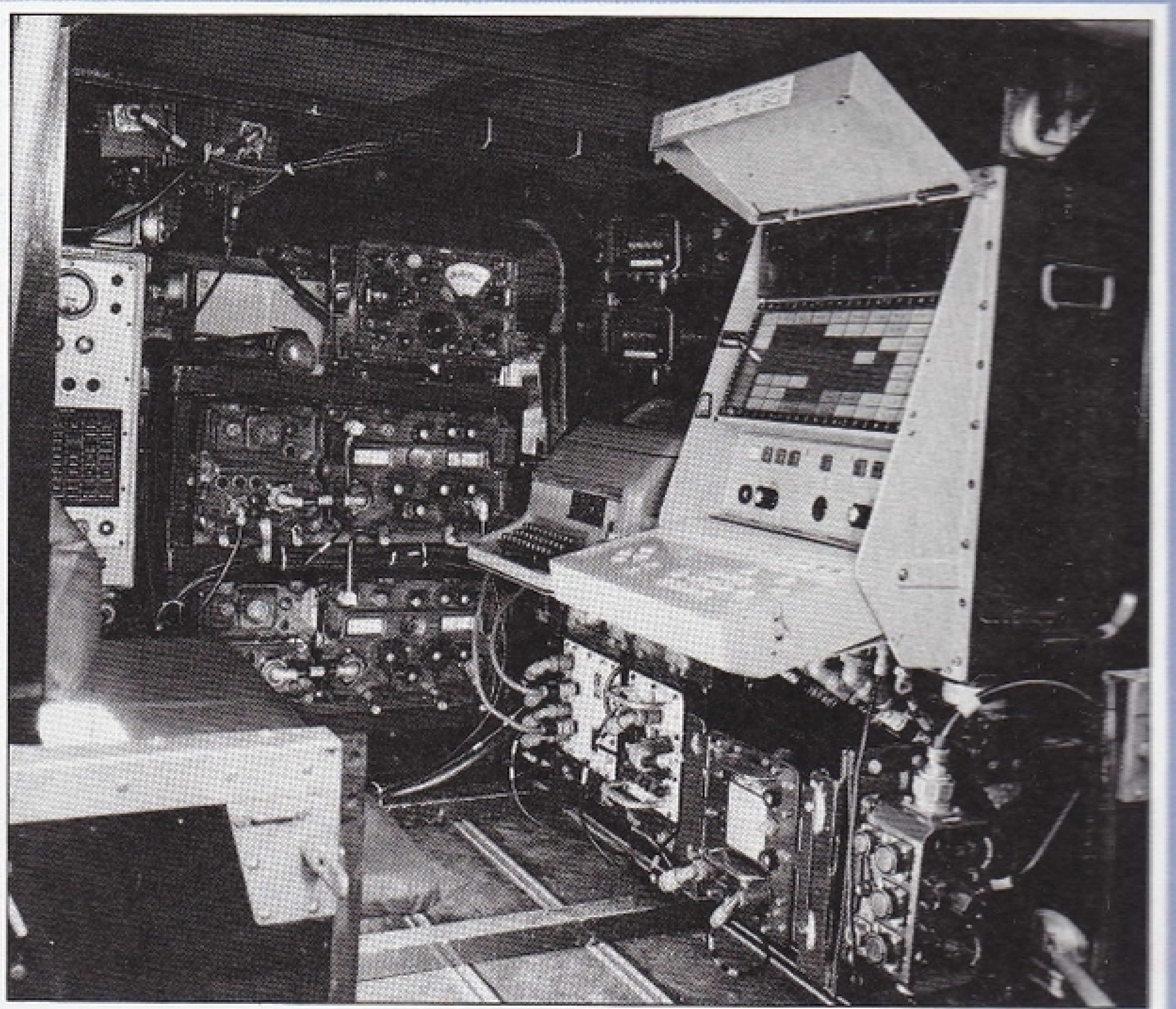
155-mm Artillery Fire Control

In recent years many armies have not only introduced new types of towed and self-propelled weapons, but also complete artillery fire-control systems that make the maximum possible use of the artillery available. This is of considerable importance within NATO, whose forces are outnumbered by a factor of three to one in artillery systems. In the past, forward observers on the ground or air observation post (AOP) aircraft radioed the position of the target to the battery commander (or higher command authority), and once the target was engaged would watch the fall of shot and then correct aim. All this took time and often wasted valuable ammunition. This basic method of fire and correction is still employed, but a number of sophisticated devices are also now standard.

Today the forward observer is often mounted in a full-tracked armoured vehicle fitted with a land navigation system so that the observer can quickly determine his own position. He also has powerful binoculars, night observation equipment and a laser rangefinder; with the last he can determine the range to the target within just a few metres. The vehicle is also fitted with extensive communications equipment to relay this information to battery headquarters for immediate action. Not all forward observers are provided with armoured vehicles, however, many having jeeps in which the forward observer is provided with a hand-held laser rangefinder (the British use the Norwegian Simrad LP7) and a rapid-burst radio. With the latter the forward observer can enter all target information, which is then stored and sent in a very short burst of radio transmission, so making detection almost impossible.

In the past most NATO artillery regiments (towed and self-propelled) normally comprised three batteries each of six guns, but the trend is now to eight-gun batteries. A typical British army 105-mm (4.13-in) Light Gun battery has a headquarters battery and three EMI Cymbeline mortar-locating radars, three batteries each with six guns, and a light aid detachment (LAD). Each battery can be split into two troops each of three guns, each of the latter being towed by 1-tonne Land Rover. At battery headquarters is a Marconi Space and Defence Systems Field Artillery Computer Equipment (FACE). In the light regiments (with 105-mm/4.13-in guns) this is mounted in a long-wheelbase Land Rover, while in the self-propelled regiments a FV432 is used. FACE, which entered service in the early 1960s and is used by many other armies (including those of Australia, Canada and Egypt), can be used both in the survey and fire-calculation roles. In the latter role information such as a gun and target position, type of ammunition to be used (e.g. smoke or high explosive), muzzle velocity of each weapon, weather data (from AMETS), temperature and charge are entered; the computer then calculates the elevation and traverse of the gun to get the projectile onto the target; and this information is then passed to each gun by word of mouth, radio or the Artillery Weapons Data Transmission System (AWDATS), one of which can be positioned alongside each gun.

The British army also uses the Artillery Meteorological System (AMETS) at artillery division level. This equipment obtains information on atmospheric conditions, which is then passed down to the battery. With the increasing range of artillery weapons AMETS plays a vital role. For example, there may be little or no wind at the battery itself, but 20 km (12.4 miles) away at the target there could be a wind of 15 km/h (9.3 mph) or more, and this would obviously have an effect on the projectile.



A long-wheelbase Land Rover of the British Royal Artillery fitted with the Marconi Space and Defence System Field Artillery Computer Equipment (FACE), which is issued on the scale of one per command post.

The EMI Cymbeline radar is in service in two models, a trailer-mounted system towed by a long-wheelbase Land Rover and a self-propelled version mounted on the FV432 armoured personnel carrier. Cymbeline has a maximum range of 20 km (12.4 miles) and can determine the position of the enemy mortar in less than 30 seconds. The US Army has recently fielded the Firefinder system, a division normally having two AN/TPQ-36 mortar-locating radars and one larger AN/TPQ-37 artillery-locating radar, both developed by the Hughes Aircraft Company, Ground Systems Division. The AN/TPQ-36 is towed by a Gama Goat and can detect both artillery and mortars, whose exact position is plotted on a roller-type map display. The AN/TPQ-36 has also been ordered by a number of other countries including Jordan, Saudi Arabia, Thailand and Australia, and in 1983 was deployed to the Lebanon by the United States in an effort to pinpoint hostile mortars and artillery systems.

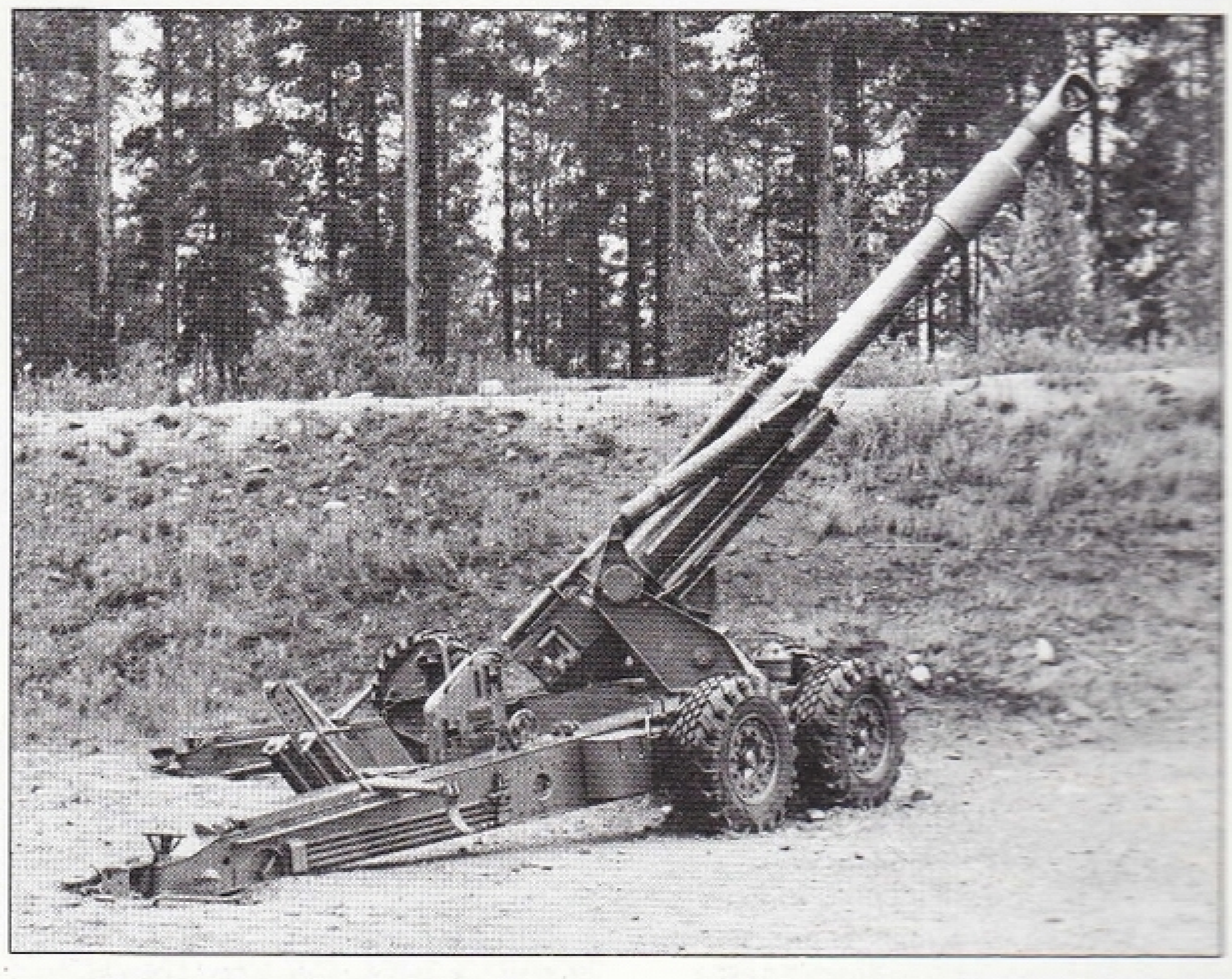
ing speed of 100 km/h (62 mph) is thus possible. When in the firing position the carriage is supported by a screw type firing jack. Four spades are carried, one of these being attached to the end of each trail for firing when the weapon is brought into action. The other two are carried to enable the eight-man crew to change direction and open fire again without taking out the original spdes.

The M-68 fires a standard NATO HE projectile weighing 43.7 kg (96.3 lb) to a maximum range of 21000 (22,965 yards), as well as smoke and illuminating projectiles. The weapon can also fire Soltam-designed projectiles with a higher muzzle velocity (820 m/2,690 ft per second compared with 725 m/2,380 ft per second) to a maximum range of 23500 m (25,700 yards).

The Soltam M-68 is no longer in volume production, although it could be placed back in production if sufficient numbers were ordered. The latest Soltam 155-mm (6.1-in) weapon is the **M-71** howitzer, which uses the same carriage, breech and recoil system as the M-68 but is fitted with a longer 39-calibre barrel. Mounted on the M-71 is a rammer powered by a compressed air cylinder on the right trail, this enabling the weapon to be loaded at all angles of elevation and so making possible a short-period fire rate of four rounds per minute. The M-71 is known to be service with the Israeli army, and fires an HE projectile to a maximum range of 23500 m (25,700 yards). For trials purposes one M-71 has been fitted with an auxiliary power unit on the left trail and an ammunition-handling crane on the right trail, with elevation increased from 52° to 70°. The APU enables the weapon, called the **Model 839P**, to propel itself on roads at a maximum speed of 17 km/h (10.6 mph), sufficient fuel being carried for a range of at least 70 km (43.5 miles)

Specification

Soltam M-68 gun/howitzer
Calibre: 155 mm (6.1 in)
Weight: travelling 9500 kg (20,944 lb) and firing 8500 kg (18,739 lb)
Dimensions: length, travelling 7.20 m (23 ft 7.5 in); width, travelling 2.58 m (8 ft 5.6 in); height, travelling 2.00 m (6 ft 6.75 in)
Elevation: +52°/−5°
Traverse: total 90°
Maximum range: 21000 m (22,965 yards)



Israeli 155-mm M-68 gun/howitzer in the firing position with trails firmly staked to the ground. The split trail carriage is unusual in that it has a total of four rubber-tyred road wheels, each of which has a hydraulic brake operated from the towing vehicle.

ITALY

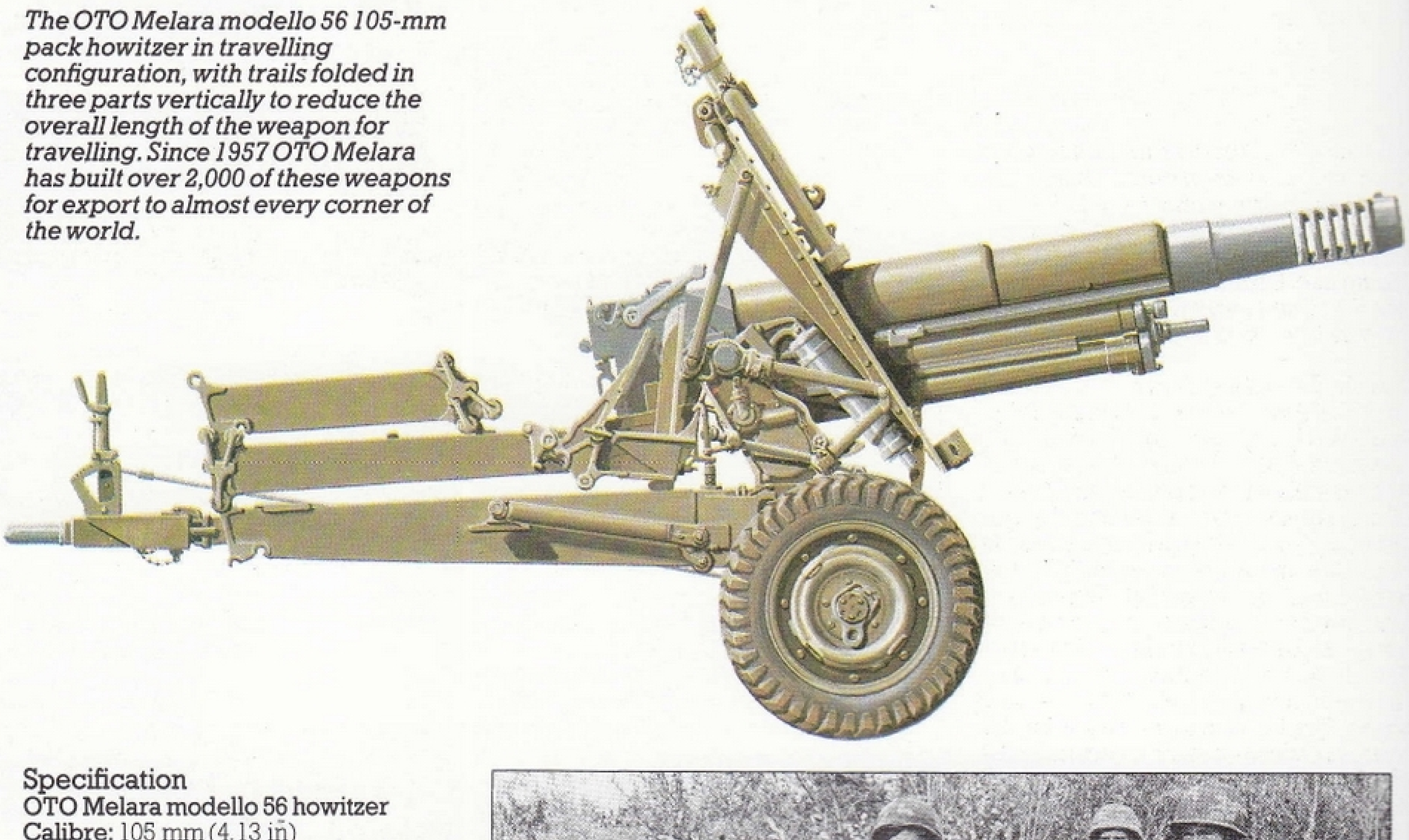
OTO Melara modello 56 105-mm pack howitzer

The mountainous terrain of northern Italy is defended by five Alpine brigades, and these and the sole Italian airborne brigade required a 105-mm (4.13-in) howitzer that could be disassembled for easy transportation across the mountains and when assembled be light enough to be air-dropped or carried slung underneath a helicopter. To meet this requirement the Italian armaments manufacturer OTO Melara at La Spezia designed a weapon that became known as the **modello 56** 105-mm (4.13-in) pack howitzer. This entered production in 1957, and was soon adopted by many countries all over the world. By 1984 some 2,400 weapons had been delivered, and the type has seen combat use in many areas. The British used it in the South Yemen and during the Borneo confrontation, while the Argentines used it in the Falklands campaign of 1982. By today's standards the modello 56 howitzer has a short range, and in the British Royal Artillery it has already been replaced by the Royal Ordnance Factory 105-mm (4.13-in) Light Gun, which has a maximum range of 17000 m (18590 yards) compared with only 10575 m (11,565 yards) for the modello 56, which is much lighter, however.

The modello 56 has a very short barrel with a multi-baffle muzzle brake, a hydraulic buffer and helical recuperator, and a vertical sliding wedge breech block. The carriage is of the split-trail type and fitted with rubber tyres for high-speed towing. An unusual feature of the modello 56 is that its wheels can be fitted in two different positions: in the normal field position the wheels are overslung, the weapon then having an elevation of +65° and a depression of −5°, and a total traverse of 36° (18° left and right); but for the anti-tank role the wheels are underslung and the weapon has an elevation of +25° and a depression of −5°, total traverse remaining 36°. The main advantage of having the wheels underslung is that the height is reduced from 1.93 m to 1.55 m (6 ft 4 in to 5 ft 1 in), so making the weapon much easier to conceal, a valuable asset in the anti-tank role.

The modello 56 can be dismantled into 11 sections for transport across rough country, and in peacetime the shield is often removed to save weight. The weapon is manned by a seven-man crew, and can be towed by a long-wheelbase Land Rover or similar vehicle. It can also be carried slung under a Bell UH-1 or Westland Wessex helicopter.

Another advantage of the modello 56 is that it fires the same ammunition as the American M101 or M102 105-mm (4.13-in) towed guns, and this ammunition is manufactured all over the world. Types of ammunition fired include an HE projectile weighing 21.06 kg (46.4 lb) with a maximum muzzle velocity of 472 m (1,550 ft) per second, as well as smoke, illuminating and HEAT (High Explosive Anti-Tank). The last weighs 16.7 kg (36.8 lb) and will penetrate 102 mm (4 in) of armour.



The OTO Melara modello 56 105-mm pack howitzer in travelling configuration, with trails folded in three parts vertically to reduce the overall length of the weapon for travelling. Since 1957 OTO Melara has built over 2,000 of these weapons for export to almost every corner of the world.

Specification

OTO Melara modello 56 howitzer

Calibre: 105 mm (4.13 in)

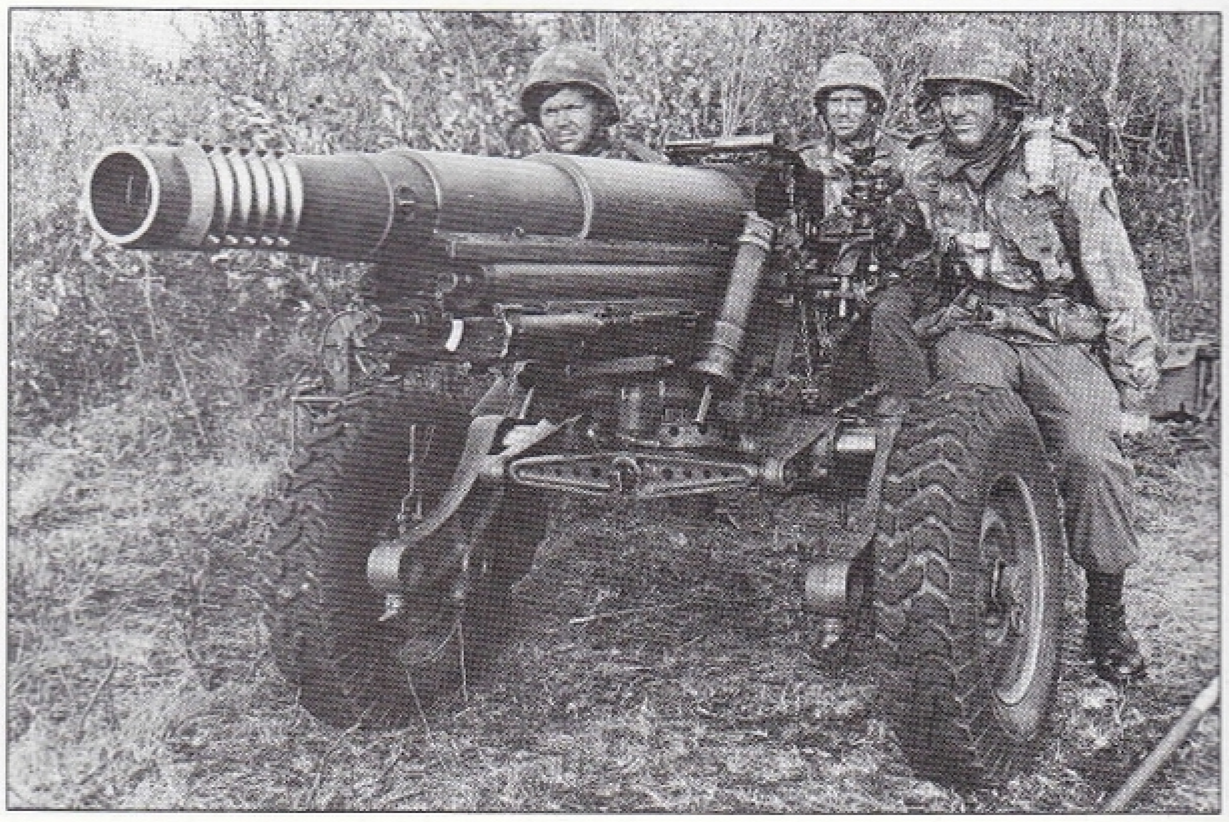
Weight: travelling 1290 kg (2,844 lb)

Dimensions: length, travelling 3.65 m (11 ft 11.7 in); width, travelling 1.50 m (4 ft 11 in); height, travelling 1.93 m (6 ft 4 in)

Elevation: +65°/−5°

Traverse: total 36°

Maximum range: 10575 m (11,565 yards)

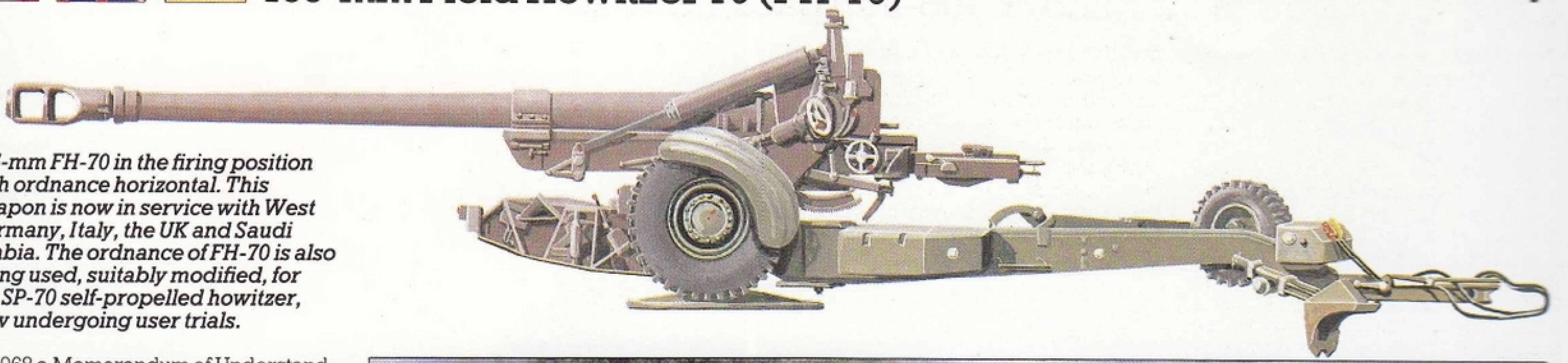


Right: OTO Melara modello 56 105-mm pack howitzer of the Canadian Armed Forces, with its shield removed to reduce its weight. This photograph clearly shows the axle arrangement that allows the overall height to be dramatically reduced when being used in the anti-tank role.

A Royal Artillery unit attached to the Royal Marine Commandos carry 105-mm pack howitzers in Norway. The normal towing vehicle is the Swedish BV 202, which was successfully used in the Falklands towing the more modern 105-mm Light Gun.

ITALY/UK/WEST GERMANY

155-mm Field Howitzer 70 (FH-70)



155-mm FH-70 in the firing position with ordnance horizontal. This weapon is now in service with West Germany, Italy, the UK and Saudi Arabia. The ordnance of FH-70 is also being used, suitably modified, for the SP-70 self-propelled howitzer, now undergoing user trials.

In 1968 a Memorandum of Understanding (MoU) was signed between the UK and West Germany for the joint development of a 155-mm (6.1-in) howitzer which would replace the 140-mm (5.5-in) gun for the former and the 155-mm (6.1-in) M114 howitzer for the latter. The main requirements of this weapon included a high rate of fire with a burst fire capability, increased range and lethality together with a new family of ammunition, high mobility and a minimum of effort for deployment. The UK was team leader for this weapon, which became known as the **FH-70**, while West Germany became team leader for the self-propelled equivalent, SP-70, which has still to enter service. Nineteen prototypes of the FH-70 were built, and in 1970 Italy joined the project as a full partner. In 1976 the FH-70 was accepted for service, the first production weapons being completed in 1978. Three production lines were established, one in the UK (Vickers Shipbuilding and Engineering Limited), one in West Germany (Rheinmetall) and one in Italy (OTO Melara). The UK ordered 71 equipments, West Germany 216 and Italy 164. The weapon has recently entered service with Saudi Arabia, and will be made under licence in Japan.

The barrel of the FH-70 is 6.022 m (19 ft 9 in) long, and has a double-baffle muzzle brake and a semi-automatic wedge-type breech mechanism. The carriage of the FH-70 is of the split-trail type, with an auxiliary power unit mounted on the forward part. This enables the FH-70 to propel itself on roads and across country at a maximum speed of 16 km/h (10 mph). In addition the APU provides power for steering, and for raising and lowering the main and trail wheels. When travelling, the ordnance is traversed to the rear and locked in position over the closed trails. To achieve the requirement for a burst-fire capability a semi-automatic loading system is fitted, and this operates at all angles of elevation. The loading system includes a loading tray that presents the projectile to the chamber. A burst rate of three rounds in 13 seconds can be achieved, while the normal rate of fire is six rounds per minute.

The FH-70 fires three main types of ammunition: HE with a weight of 43.5 kg (95.9 lb) smoke (base ejection), and illuminating. The last provides one million candelas for one minute. The FH-70 can also fire the Martin Marietta Cannon-Launched Guided Projectile (CLGP), although this has yet to be adopted by any European member of NATO, and the US M549A1 rocket-assisted projectile, which has a range of 30000 m (32,810 yards).

The FH-70 has an eight-man crew, and each country having a different towing vehicle: West Germany uses the MAN (6×6) 7-tonne truck, Italy the FIAT 66066 TM (6×6) truck, and the UK the Foden Medium Mobility Vehicle (6×6), which shares many common automotive components with the Low Mobility range of vehicles used in large numbers by the British army.

Above: 155-mm FH-70s of the British Royal Artillery on the ranges. This weapon fires a high explosive projectile to a maximum range of 24000 m (26,245 yards), although a rocket assisted projectile can also be fired with a longer range.

Right: 155-mm FH-70 firing at high angle during trials in Sardinia some years ago. The UK is project leader for the FH-70, while West Germany is project leader for the SP-70. Each of the three producing countries do use different towing vehicles.

Specification

FH-70 field howitzer
Calibre: 155 mm (6.1 in)
Weight: travelling and firing 9300 kg (20,503 lb)
Dimensions: length, travelling 9.80 m (32 ft 1.8 in); width, travelling 2.204 m (7 ft 2.75 in); height, travelling 2.56 m (8 ft 4.8 in)
Elevation: +70°/−5°
Traverse: total 56°
Maximum range: with standard round 24000 m (26,245 yards) and with rocket-assisted projectile 30000 m (32,810 yards)

155-mm Ammunition

It is not always realized that today, as in the past, a gun or howitzer is normally designed and developed around the ammunition that it is to fire. An army issues a requirement for a weapon to fire a projectile of a specified weight to a determined range, an overall acceptable weight being placed on the complete weapon. The latter feature has become more important in recent years, as most medium-calibre weapons such as the US 155-mm (6.1-in) M198 have to be capable of being carried slung under helicopters or readily transported by air. During World War II medium-calibre weapons such as the US 155-mm (6.1-in) M114 towed howitzer fired only a small selection of ammunition including high explosives, smoke and chemical (with various fillings such as white phosphorus, mustard gas and titanium tetrachloride). Since then much development work has been carried out on ammunition, and the 155-mm (6.1-in) M198 of today can fire a wide range of ammunition to defeat a variety of battlefield targets, including armoured vehicles. Listed below are the types of ammunition fired by the M198.

RAAM (Remote Anti-Armor Mine System)

This has only recently entered service with the US Army, and is a projectile that carries nine anti-tank mines, each weighing 2.27 kg (5 lb) and ejected from the projectile as it passes over the target area. The **M741** projectile carries nine anti-tank mines which will self-destruct if they are not set off by a vehicle in 24 hours, while the **M718** projectile carries a similar number of mines with a longer period before they self-detruct.

HE (M107)

The high explosive M107 projectile weighs 42.91 kg (94.6 lb) and contains 6.62 kg (14.6 lb) of TNT or 6.98 kg (15.4 lb) of Composition B.

HE (M449)

This projectile weighs 43.09 kg (95 lb) and contains 60 M43 anti-personnel grenades dispensed over the target. This projectile is also effective against soft-skinned vehicles and troops in the open.

HE (M483)

This projectile weighs 46.53 kg (102.6 lb) and contains 88 (64 M42 and 24 M46) dual-purpose grenades for use against personnel and vehicles, the roof of the latter being one of their most vulnerable points.

ADAM (Area-Denial Artillery Munition)

This is in service only with the US Army and carries 36 anti-personnel mines. The **M692** projectile carries 36 mines that will self-destruct over a longer period than those of the M731 projectile, whose 36 mines self-destruct after a period of 24 hours if not activated.

Nuclear

The M198 can fire a nuclear projectile, the **M795** being used as a spotting round.

A 155-mm shell leaves the barrel of a US Army Sheridan light tank.

HERA (M549)

The High Explosive Rocket Assisted projectile weighs 43.54 kg (96 lb) and has a rocket motor at the rear that increases its range to 30000 m (33,810 yards) compared with the standard M107 projectile which has a maximum range of 18150 m (19,850 yards) when fired by the M198.

REMBASS

This projectile carries a number of sensors that drop to the ground and are difficult to detect. These relay information on vehicles and personnel in their immediate area, and this information is used both for surveillance and target-acquisition purposes.

Smoke

The white phosphorus projectile is called the **M110** while the smoke (base ejection) projectile is called the **M116**. There are also special projectiles for CS gas and chemical agents.

Jammer

Under development is a 155-mm (6.1-in) projectile that will drop expendable communications jammers well to the rear of the front line to disrupt enemy communications systems.

Illuminating

The M198 can fire two types of illuminating projectile, the **M118** and the **M485**, the latter being the more recent.

UK

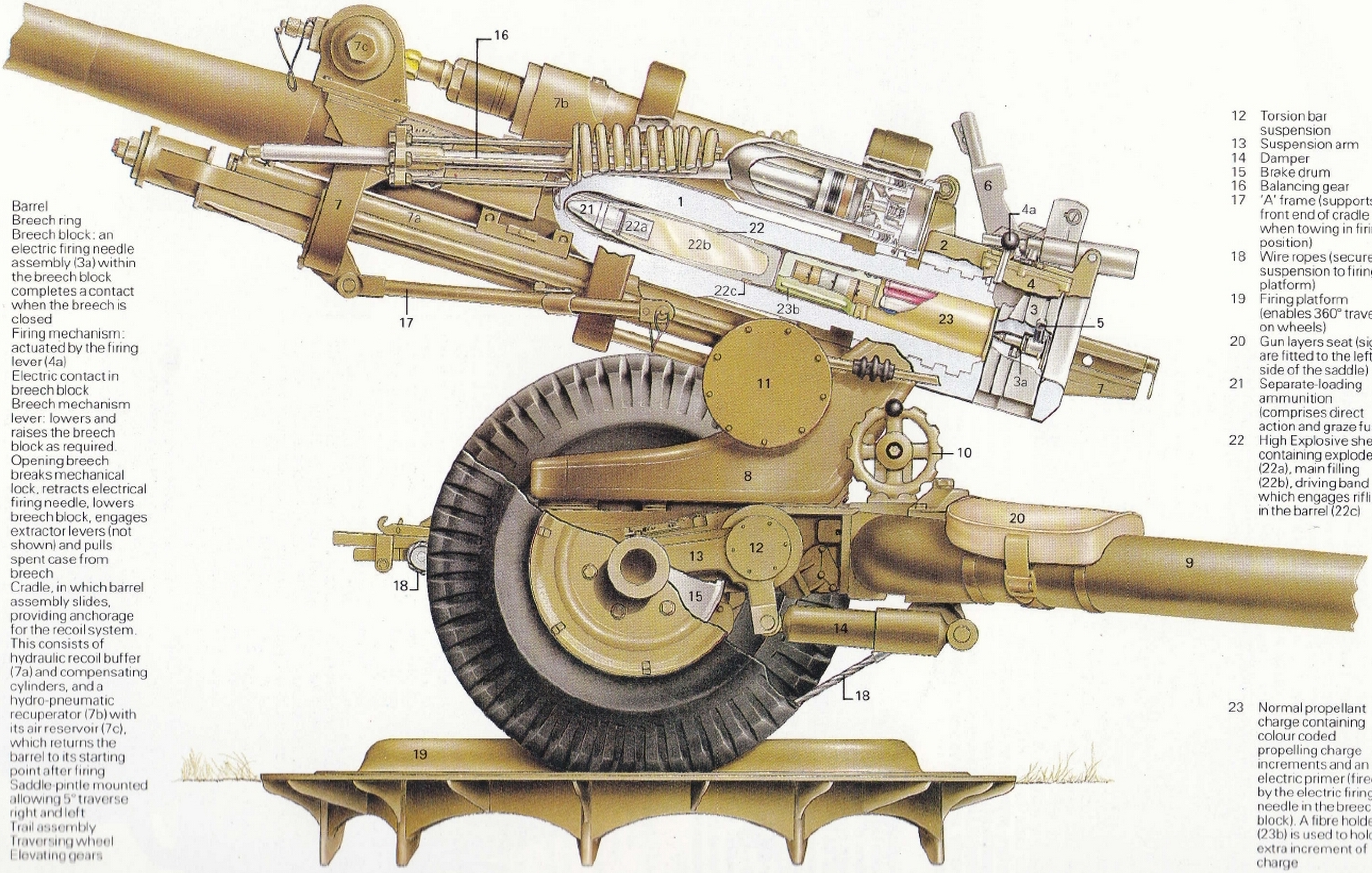
105-mm Light Gun

In 1959 the Royal Artillery adopted the Italian OTO Melara 105-mm (4.13-in) pack howitzer as its standard weapon for employment with airborne and air-portable units, and this subsequently gave excellent service in such places as Aden and Borneo. The weapon's main drawback from the British point of view was its relatively short range of 10575 m (11,565 yards). So in 1965 the Royal Artillery issued a requirement for a replacement weapon with a longer range, ability to be towed across country at high speed and a more stable firing platform. Design work began at the Royal Armament Research and Development Establishment in 1966, and after the construction of prototypes, field tests and the resultant modifications the **105-mm Light Gun** was accepted for service in 1973. The first production weapons were completed at Royal Ordnance Factory Nottingham in 1974. In the Royal Artillery the weapon is issued on the scale of 18 guns per regiment, each battery having six guns. With the Royal Artillery the weapon is deployed only in the United Kingdom and Belize, and with the Gibraltar Regiment. So far over 400 Light Guns have been built, and sales have also been made to Australia (which is producing the weapon and its ammunition under licence), Brunei, Eire, Kenya, Malawi, Oman and the United Arab Emirates, and a number of other undisclosed countries. In the British army the weapon is towed by a 1-tonne Land Rover. This is no longer produced, however, and the Light Gun can be towed by a number of other tracked and wheeled vehicles, including the Swedish Bv 202 all-terrain vehicle. The Light Gun can also be slung under a helicopter such as an Aérospatiale Puma, while the smaller Westland Wessex can take it in two loads.

Two types of barrel can be fitted. The standard barrel is the L19A1, which fires the Abbott range of ammunition out to 17200 m (18,810 yards), and there is also the shorter L20A1 barrel, which fires the standard American M1 series of ammunition out to 11000 m (12,030 yards). Many countries keep the Light Gun with the short barrel for training purposes as the ammunition is much cheaper and available from a variety of manufactur-

The Royal Ordnance Factory's 105-mm Light Gun fires at maximum elevation during demonstrations at the Royal School of Artillery at Larkhill, Wiltshire. The 105-mm Light Gun has now replaced the Model 56 Pack Howitzer in the Royal Artillery, and not only has a longer range but also fires the same highly lethal range of ammunition as the Abbot 105-mm self-propelled gun used by the British and Indian armies.

Royal Ordnance Factory 105-mm Light Gun cutaway drawing



1 Barrel
2 Breech ring
3 Breech block: an electric firing needle assembly (3a) within the breech block completes a contact when the breech is closed
4 Firing mechanism: actuated by the firing lever (4a)
5 Electric contact in breech block
6 Breech mechanism lever: lowers and raises the breech block as required. Opening breech breaks mechanical lock, retracts electrical firing needle, lowers breech block, engages extractor levers (not shown) and pulls spent case from breech
7 Cradle, in which barrel assembly slides, providing anchorage for the recoil system. This consists of hydraulic recoil buffer (7a) and compensating cylinders, and a hydro-pneumatic recuperator (7b) with its air reservoir (7c), which returns the barrel to its starting point after firing
8 Saddle-pintle mounted allowing 5° traverse right and left
9 Trail assembly
10 Traversing wheel
11 Elevating gears
12 Torsion bar suspension
13 Suspension arm
14 Damper
15 Brake drum
16 Balancing gear
17 'A' frame (supports front end of cradle when towing in firing position)
18 Wire ropes (secures suspension to firing platform)
19 Firing platform (enables 360° traverse on wheels)
20 Gun layers seat (sights are fitted to the left side of the saddle)
21 Separate-loading ammunition (comprises direct action and graze fuse)
22 High Explosive shell containing exploder (22a), main filling (22b), driving band which engages rifling in the barrel (22c)
23 Normal propellant charge containing colour coded propelling charge increments and an electric primer (fired by the electric firing needle in the breech block). A fibre holder (23b) is used to hold an extra increment of charge

105-mm Light Gun (continued)

ers in almost every corner of the world.

The ordnance (barrel) of the Light Gun is fitted with a double-baffle muzzle brake, a hydropneumatic recoil system and a vertical sliding breech mechanism. Traverse is limited to 5.5° left and right, but when the Light Gun is positioned on its turntable, which is normally carried over the bow-type trails, it can be quickly traversed through 360° to be laid onto a new target. When travelling, the ordnance is normally traversed over the trails to make it more compact.

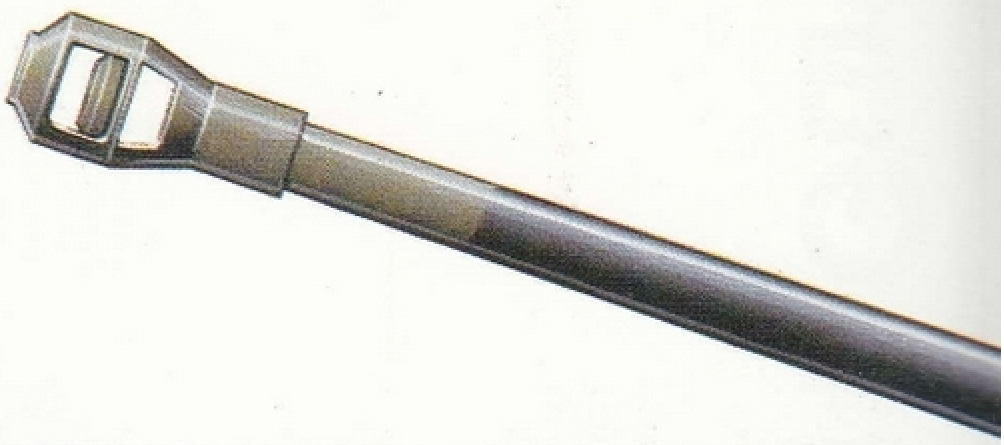
The ammunition fired by the Light Gun is identical to that fired by the Abbott 105-mm (4.13-in) self-propelled gun, is manufactured by the Royal Ordnance Factories, and includes HE (projectile weight 16.1 kg/35.5 lb), HE squash head (for engaging tanks and other targets), squash head practice and smoke (three colours).

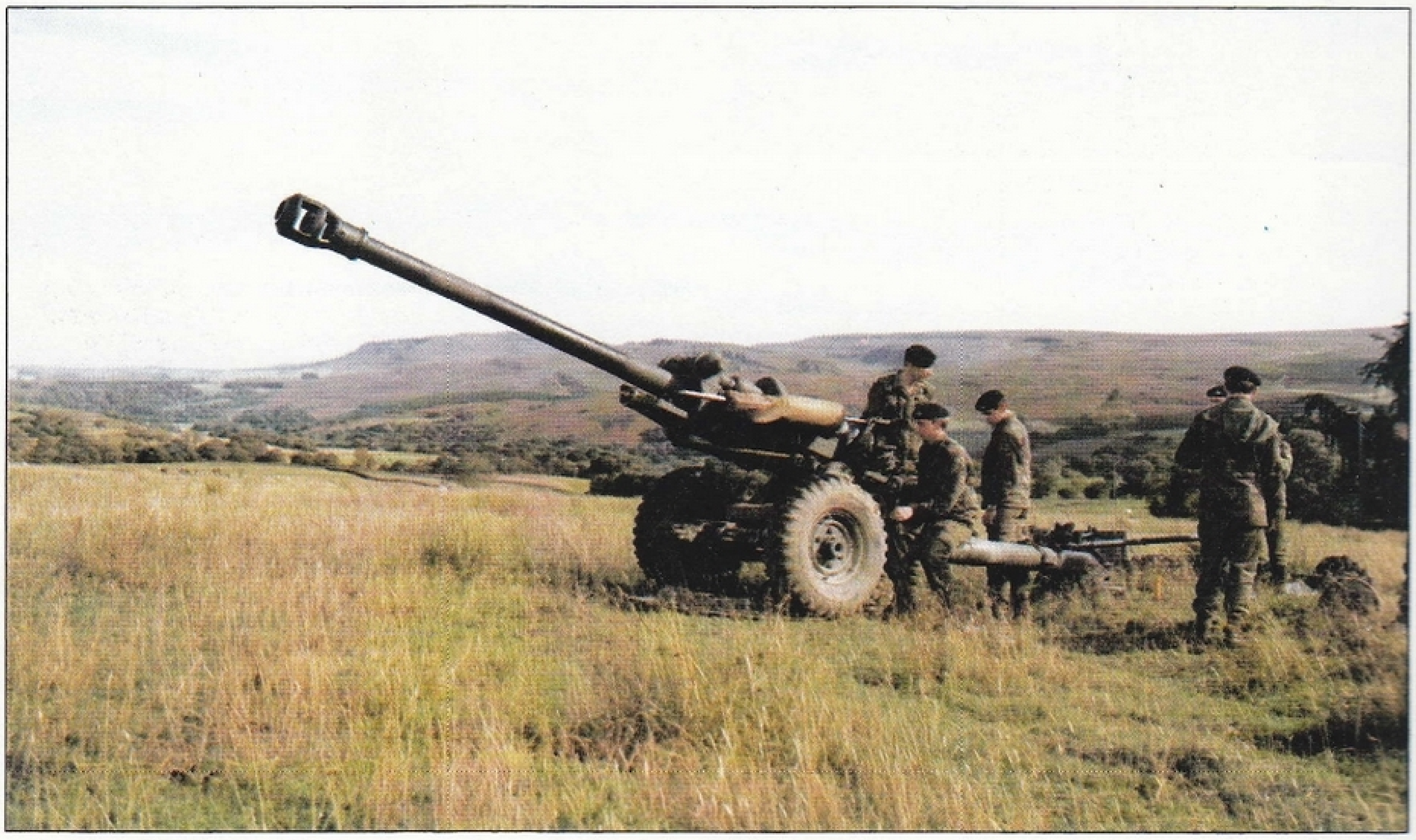
The Light Gun proved to be a highly effective weapon in the Falklands campaign of 1982, and since then a number of Light Guns have been permanently retained as part of the islands' garrison.

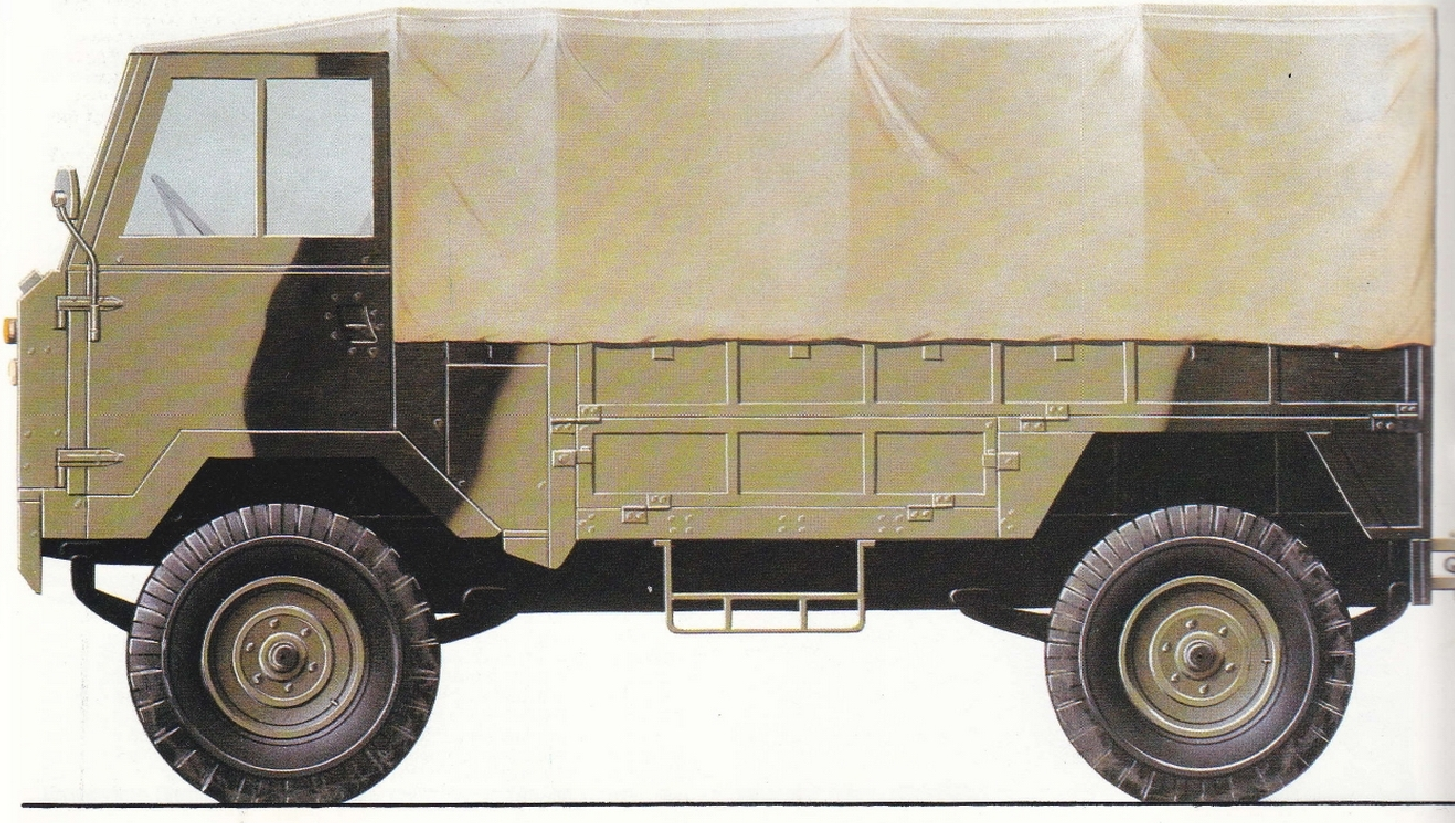
Specification

105-mm Light Gun
Calibre: 105 mm (4.13-in)
Weight: firing and travelling 1858 kg (4,096 lb)
Dimensions: length, travelling (gun over trail) 4.876 m (16 ft 0 in); width, travelling 1.778 m (5 ft 10 in); height, travelling (gun over trail) 1.371 m (4 ft 6 in)
Elevation: +70°/−5.5°
Traverse: total 11° or on turntable 360°
Maximum range: 17200 m (18,810 yards)

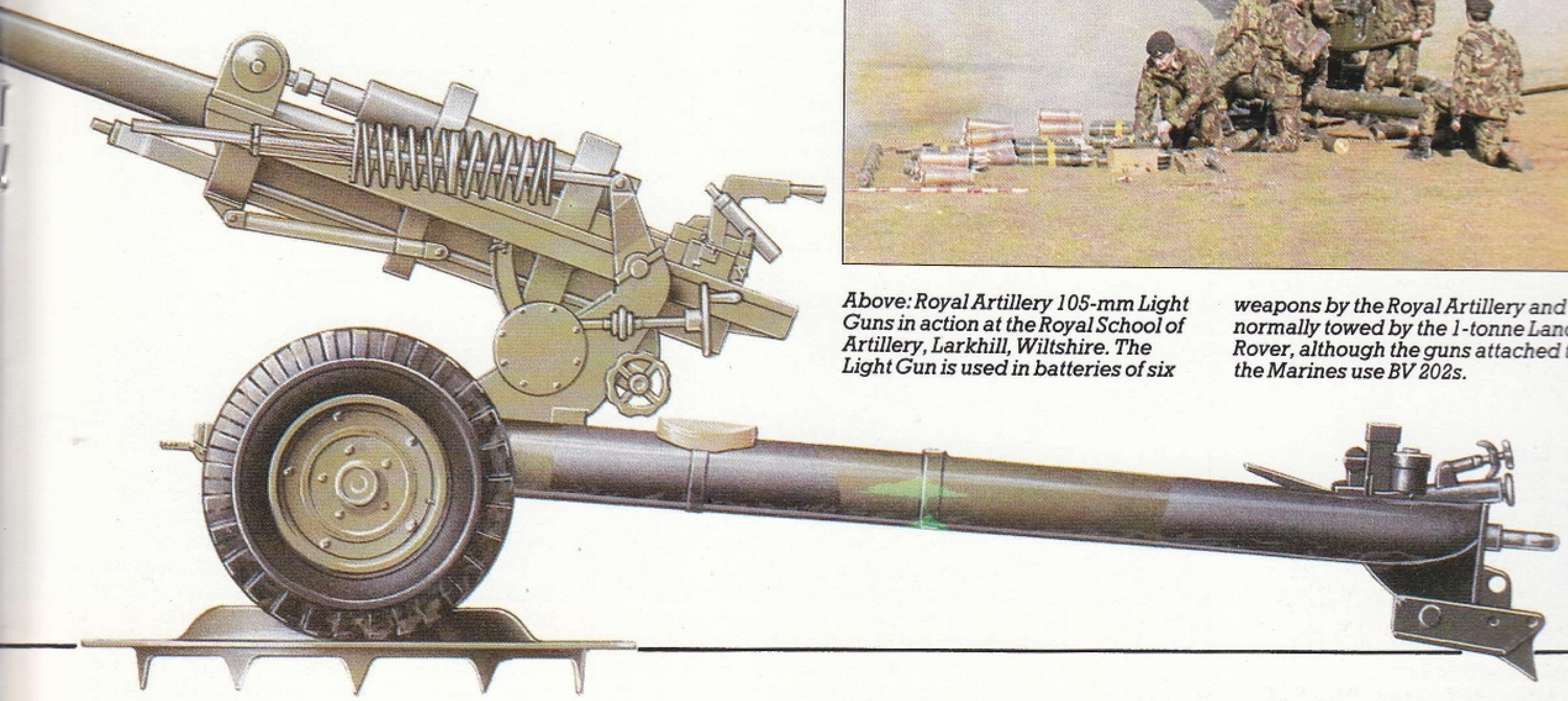
Below: Royal Ordnance Factory Nottingham 105-mm Light Gun in the firing position. This weapon has now replaced the 105-mm Pack Howitzer in the light regiments of the Royal Artillery and is deployed in the UK, Belize and with the Gibralter Regiment. Over 400 have now been built for both the home and export markets, and it has the longest range of any weapon of its type in the world today.







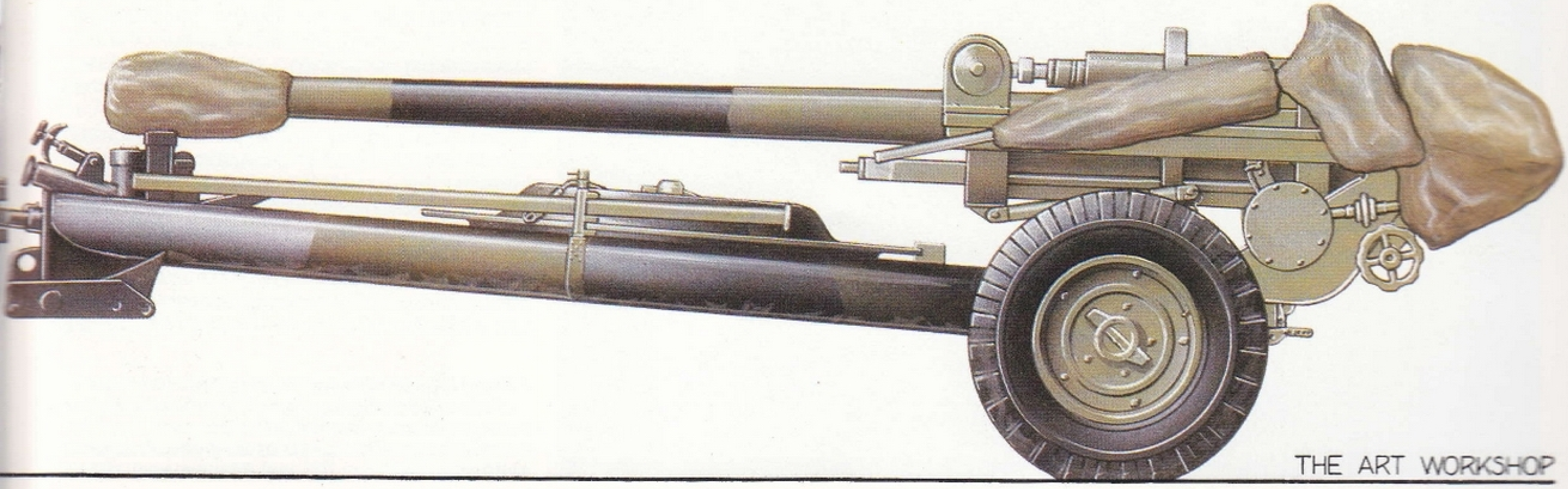
Above: Royal Artillery 105-mm Light Guns in action at the Royal School of Artillery, Larkhill, Wiltshire. The Light Gun is used in batteries of six weapons by the Royal Artillery and is normally towed by the 1-tonne Land Rover, although the guns attached to the Marines use BV 202s.



To tow the 105-mm Light Gun the Royal Artillery use the 1-tonne Land Rover, which also carries the crew and some ready-use ammunition. A total of 2,500 vehicles were built for the British Army, with exports being made to Australia, Egypt and Luxembourg. The vehicle is powered by a Rover V-8 petrol engine that develops 128 bhp (95 kW) at 5,000 rpm and gives a maximum road speed of 120 km/h (74 mph). The driver and one passenger are seated at the front with the engine between them, and the eight men are seated four along either side of the rear.

Above: 105-mm Light Gun in the ready-to-fire position on its turntable, which is normally carried on top of the trail when not required. When the road wheels are running on the turntable the 105-mm Light Gun can be quickly traversed through a full 360 degrees in seconds, as without the turntable traverse is limited to 5.5 degrees left and right. The 105-mm Light Gun is in service in two models, long barrel and short barrel. The former is normally used operationally and with Abbot type ammunition allows a range of 17200 m (18,810 yards) to be achieved. The shorter barrel is normally used for training, as it fires the much cheaper M1 type ammunition with a maximum range of 11000 m (12,030 yards). In addition to being used by the British Royal Artillery, it is also in service with many overseas countries, including Australia (being made under licence), Brunei, Ireland, Kenya, Malawi, Oman and the United Arab Emirates. A special has been developed by Royal Ordnance Factory Nottingham to meet the requirements of the Swiss army, but this has not so far been placed in production, although the factory is still hoping for a major contract.

Below: When the 105-mm Light Gun is being towed, the ordnance is normally traversed over the bow-type trails and locked in position to reduce the overall length of the system. To achieve this position the carriage on one side is jacked up, the road wheel is quickly removed, ordnance is manually swung through 180 degrees until it is over the trails, clamped into position, the wheel replaced and jack removed. This takes just one minute to accomplish in the field, although it can also be towed with the ordnance in the normal firing position.



THE ART WORKSHOP

Artillery in the Falklands

The five Royal Artillery batteries deployed during the 1982 Falklands campaign played a major role in the defeat of the Argentine forces. The 105-mm Light Guns completely outranged the Argentine 105-mm Pack Howitzers, which were also handicapped by bad fire control, and the weight of the four Argentine 155-mm weapons available restricted their use to the area around Port Stanley.

The artillery battle of the Falklands campaign of 1982 was fought between the flexible and co-ordinated firepower of five Royal Artillery batteries of 105-mm (4.13-in) Light Guns, with a number of naval 114-mm (4.5-in) guns on Royal Navy ships offshore in support, and an Argentine force of five six-gun batteries of 105-mm (4.13-in) OTO Melara modello 56 pack howitzers and a single four gun battery of 155-mm (6.1-in) L33 X1415 CITEFA modelo 77 howitzers comprising the 3rd and 11th Artillery Groups. The 155-mm (6.1-in) howitzers were airlifted into Port Stanley from 15 May onwards by Argentine air force Lockheed C-130 Hercules transports specifically to defend that area against bombarding warships. Both the 155-mm (6.1-in) and 105-mm (4.13-in) guns were used in action against Royal Navy ships on a number of occasions.

Although the first shots in the artillery war were fired by the Royal Navy's surface action group comprising the destroyer HMS *Glamorgan* and the frigates HMS *Arrow* and HMS *Alacrity* whilst bombarding Argentine positions around Port Stanley on 1 May, naval gunfire support (NGS) from HMS *Antrim* and HMS *Plymouth* had already been instrumental in the recapture of South Georgia on 25 April. On many nights after 1 May Royal Navy vessels were used to bombard various Argentine positions around the islands and to provide the fire support required for the successful SAS raid on the Argentine naval air base of Calderon on Pebble Island that took place on the night of 14/15 May. During the amphibious landings at San Carlos on 21 May NGS was used under the direction of specialist Royal Artillery NGS forward observer (NGSFO) teams from the 148th Forward Observation Battery of the 29th Commando Regiment, Royal Artillery. One team was assigned to the 3rd Commando Brigade, another to the 5th Infantry Brigade and the remaining three to the Special Forces units which roved over the islands on reconnaissance patrols. It was one of the latter that had landed with the Special Boat Squadron (SBS) some five days before the main landings to prepare and reconnoitre the beach-head zone. In the days that followed these teams were often able to call down both gunfire and RAF BAe Harrier airstrikes exactly when and where needed, a factor which contributed much to the overall victory.

Included amongst the San Carlos landings of 21 May were the three six-gun batteries of the 29th Commando Regiment, Royal Artillery, and one battery of the 4th Field, with their L118A1 Light Guns. A further battery and Regimental Headquarters of the 4th Field was landed at the beginning of June to support the 5th Infantry Brigade, and its detached battery was returned to it. However, the first battery actually in action was the 8th (Alma) Commando Battery of the 29th Commando Regiment, which initially used three of its guns from a position established at Camilla Creek House in support of the 2nd Battalion, The Parachute Regiment during the latter's actions at Darwin and Goose Green; the other three guns were brought forward by helicopter on the morning of 29 May for the final attack. During these actions HMS *Arrow* provided fire support and starshell illumination until the dawn on 28 May from her solitary 114-mm (4.5-in) gun under NGSFO direction, although at one critical stage her gun jammed. Throughout the battle the Argentines continually harassed the attacking force with fire from an artillery group that included four 105-mm (4.13-in) pack howitzers and six 120-mm (4.72-in) mortars taken from the main garrison at Port Stanley. The majority of the Argentine rounds failed to explode in the soft ground, and those that did had their explosive effects very much reduced.

With the way cleared, the approach to Port Stanley was started. This was marked not so much by battles but more by the incredible logistical efforts required to relocate the guns and feed them with a continuous supply of ammunition. The sinking of the *Atlantic Conveyor* had meant the loss of three-quarters of the Boeing Vertol Chinook helicopter force that was needed to lift the ammunition supplies for the batteries. This left only one Chinook heavy-lift helicopter and a number of medium-lift Westland Sea King HC.Mk 4 and converted Sea King HAS.Mk 2 helicopters for the purpose. It could also carry up to three guns and their crews in one load and the Sea Kings either one gun or a load of 60 rounds of ammunition slung underneath. The Chinook could carry up to 10 tons of ammunition in a single lift. The logistical effort required is given the right perspective when it is realized that each gun was deemed to require at least 500 rounds for its immediate reserve, and this level had to be maintained for every engagement without the help of resupply vehicles.

Gun batteries forward

Once the area of Mount Kent had been secured on the night of 30 May, the Light Gun batteries were brought forward and emplaced in built-up earth revetments on flat terrain. The normal practice of digging gunpits was impossible as anything below one spade's depth rapidly filled with water. The guns were then covered with as much camouflage netting as possible to prevent aerial observers from pinpointing the locations. As the ground was so soft the guns tended to sink into it during prolonged firing, so much so that after relatively very few rounds the gunners had to drag the gun out and re-bed it. This, coupled with the necessity of humping the 15.875-kg (35-lb) shells from the distant points where the helicopters had dropped the ammunition pallets to the immediate-use ammunition dumps and then to the guns themselves, added considerably to fatigue amongst the gun crews.

During the attacks on 11/12 June against Mount Longdon, Two Sisters and Mount Harriet, the attacking British forces very often found themselves following close behind the supporting fire from the artillery and naval guns. They also found themselves under considerable enemy fire from the 105-mm (4.13-in) and 155-mm (6.1-in) guns located in and around Port Stanley. Both 2nd and 3rd Battalions, The Parachute Regiment (near and on Mount Longdon respectively) received a large number of ground- and air-burst shells from the 155-mm (6.1-in) howitzers directed by Argentine observers located on Mount Tumbledown, which overlooked Mount Longdon. For the final assaults on 13 June against Tumbledown, Wireless Ridge and Mount William the British fired over 6,000 rounds in something like 12 hours. Although once again under accurate counterbattery fire, the Argentine artillery replied to this barrage, the unfortunate 2nd Battalion, The Parachute Regiment, getting another working over from the 155-mm (6.1-in) howitzers during their attack on Wireless Ridge. It was during this particular operation that one of the mischances that happens in any war occurred when five rounds of 105-mm (4.13-in) HE

A Royal Navy Westland Sea King lifts a 105-mm Light Gun from ship to shore. The difficult terrain on the Falklands meant that artillery and ammunition had to be helicopter-portable to be of any use.

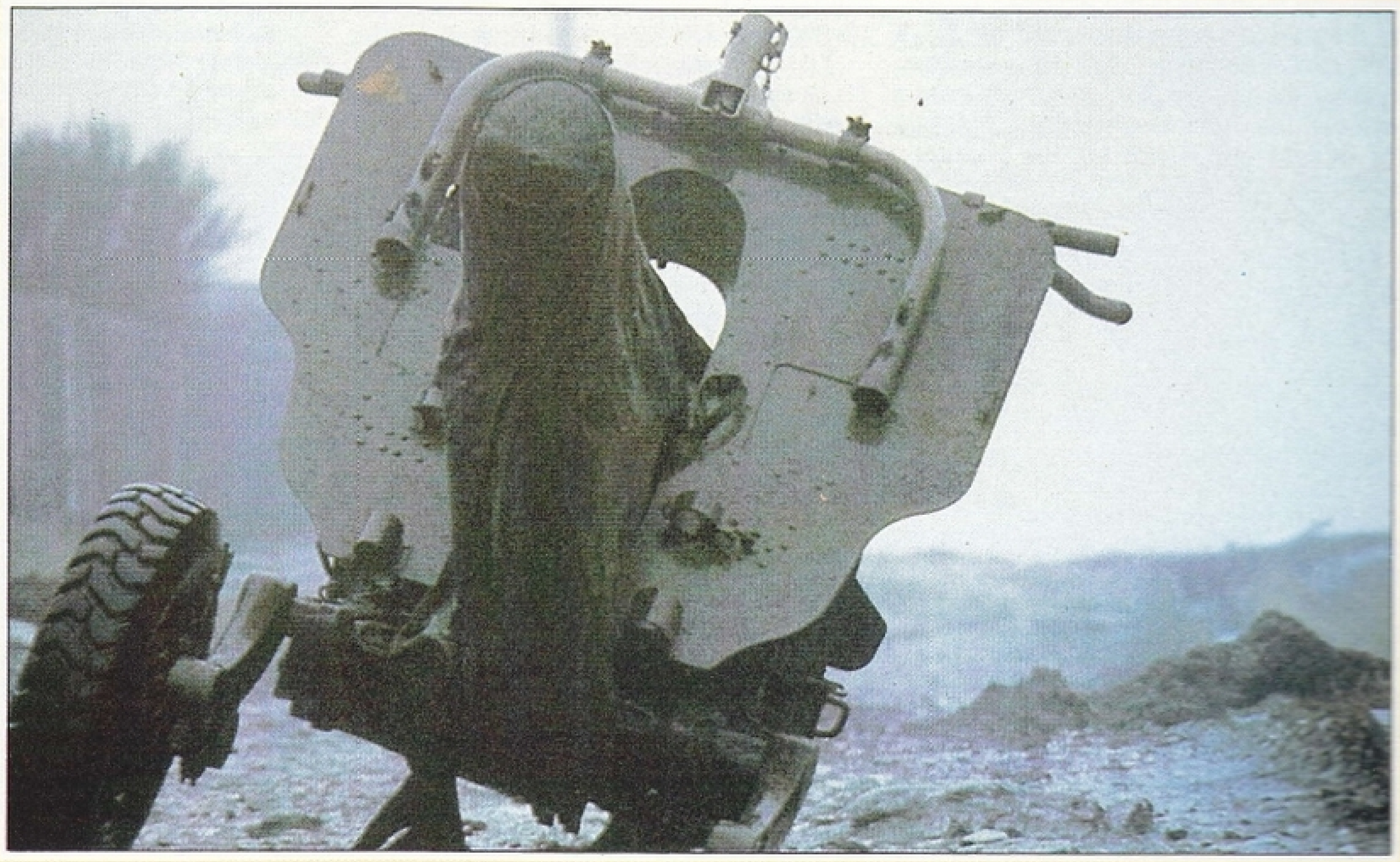
The bleak, windswept landscape of East Falkland offers little protection against hostile fire. Scots Guardsmen, digging in prior to the epic battle for Mount Tumbledown, are exposed to fire from the Argentine 155-mm battery in Port Stanley.

shells from a Light Gun battery fell short into a position occupied by a platoon of D Company, 2nd Battalion, killing one man instantly and wounding another.

As the Argentine forces retreated from their positions it was the 105-mm (4.13-in) Light Guns that helped to break up the only counterattack that the enemy attempted during the whole war, when a platoon-sized force attempted to assault the positions held by the 2nd Battalion, The Parachute Regiment. The artillery also engaged the retreating Argentine forces until they surrendered. The surviving Argentine artillery pieces were then claimed as war trophies and a number of them, including examples of the modelo 77 155-mm (6.1-in) howitzer, were sent back to the UK.

Although much of the artillery support it required had been supplied either by the Royal Artillery or Royal Navy, the infantry had been able to provide some of its own support in the form of mortar fire. Each of the Royal Marine Commandos, army parachute battalions and infantry battalions involved had an integral mortar unit with six 81-mm (3.19-in) L16A1 mortars. These weapons have maximum and minimum ranges of 5650 m (6,175 yards) and 180 m (197 yards) respectively, and can fire 4.47-kg (9.85-lb) high explosive, white phosphorus, smoke and illuminating projectiles. Because of the lack of extensive helicopter or suitable vehicle transport these weapons had unfortunately to be man-packed across East Falkland in three loads (barrel, bipod and baseplate) together with first line ammunition they required. Moreover, they needed to be dug out of the ground every so often as recoil forces forced them into the soft soil. To alleviate this problem a simple device, called the Raschen Bag after its inventor, was used. This was simply a canvas bag filled with whatever soil, stones or other suitable material was to hand, and placed under the baseplate to spread the recoil forces over a much wider areas, thus reducing the sinking rate.

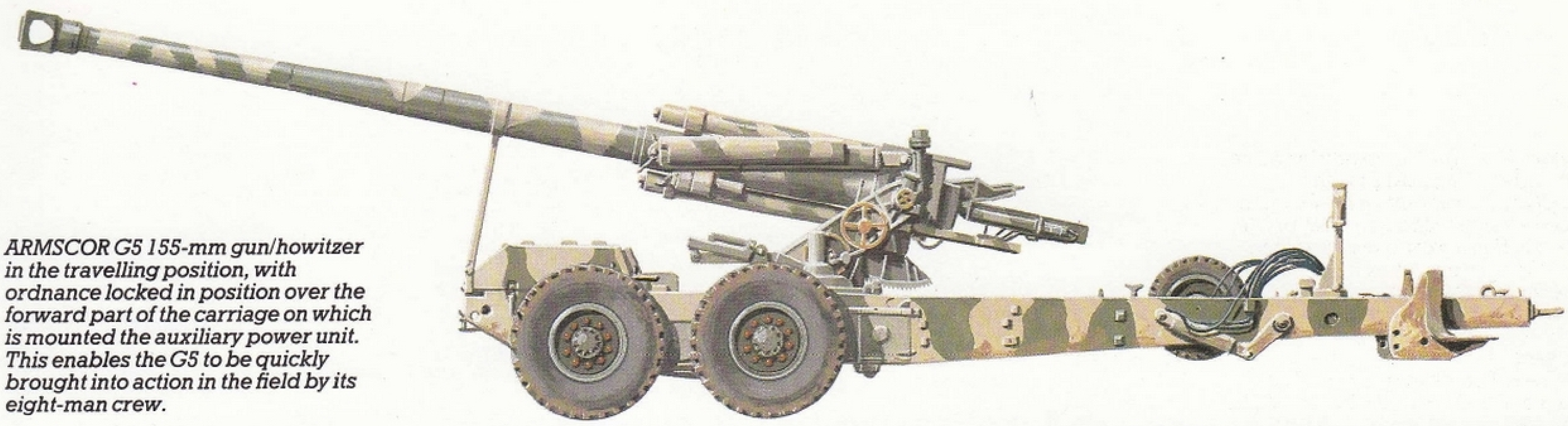
After the war the Royal Artillery units present regrouped and were sent home, although a number of Light Guns remain with the Falklands garrison. No larger artillery guns such as the FH70 155-mm (6.1-in) piece have been sent out because anything heavier than the 105-mm (4.13-in) Light Gun would be extremely difficult, if not impossible, to manoeuvre on the soft terrain, and because even where they could be used the logistic back-up required to move their ammunition around the islands would be beyond the facilities available other than in areas close to the main military installations. Thus their effectiveness would be considerably reduced, as the Argentines found in having to limit their 155-mm (6.1-in) howitzers to Port Stanley, when forward basing them within reach of the San Carlos landing beaches would have created considerable problems for the British forces.



This Italian OTO Melara modello 56 105-mm Pack Howitzer was captured by the British in the 1982 Falklands campaign. The Argentinians deployed five six-gun batteries of these weapons to the islands, together with four 155-mm howitzers.

SOUTH AFRICA

G5 155-mm gun/howitzer



ARMSCOR G5 155-mm gun/howitzer in the travelling position, with ordnance locked in position over the forward part of the carriage on which is mounted the auxiliary power unit. This enables the G5 to be quickly brought into action in the field by its eight-man crew.

For many years after World War II the mainstay of the South African field artillery units were the British 140-mm (5.5-in) medium gun with a maximum range of 16460 m (18,000 yards) and the 25-pdr (88-mm) field gun with a maximum range of 12250 m (13,395 yards). During operations in Angola the South Africans found themselves outranged by enemy artillery and rocket fire and this led to the development of two indigenous systems as no Western country would supply South Africa with the arms it required. These systems, the **G5** 155-mm (6.1-in) gun/howitzer and the 127-mm (5-in) 24-round multiple rocket system, are now in production and service with the South African army and have seen combat during deep-penetration raids into Angola.

The G5 owes much to the Canadian Space Research Corporation GC 45 155-mm (6.1-in) weapon, of which 12 are in service with the Thai Marines, but so many additional features have been incorporated into the G5 that this now bears little resemblance to the original Canadian weapon.

The G5 has a 45-calibre barrel fitted with a single-baffle muzzle brake and an interrupted-thread breech mechanism. To the rear of the breech is a pneumatically-operated rammer to ram projectiles into the chamber at all angles of elevation; this is powered by an air bottle mounted on the right trail. The bagged charges are loaded by hand. On the forward part of the split trail carriage is the auxiliary power unit, which consists of a 68-hp (51-kW) diesel engine. In addition to providing power to the main driving wheels, the APU also supplies power for raising and lowering the circular firing platform under the carriage, for opening and closing the trails, and for raising and lowering the trail wheels. To reduce the overall length of the G5 for travelling, the ordnance is normally traversed through 180° and locked in position over the trails. The ordnance has a total traverse of 84° and up to 15° of elevation, and 65° above 15° of elevation. Maximum rate of fire over a 15 minute period is three rounds per minute, with two rounds per minute possible in the sustained fire role. The weapon is operated by an eight-man crew, and is normally towed by a South African-built SAMIL 100 (6×6) 10-tonne truck which carries the crew, projectiles, charges and fuses.

The G5 can fire five types of ammunition, also manufactured in South Africa by ARMSCOR. The standard HE projectile weighs 45.5 kg (100.3 lb) and is of the Extended-Range Full Bore (ERFB) type. The HE base-bleed (HE BB) type is slightly heavier because of the base-bleed attachment, but has a range of 37000 m (40,465 yards) at sea level, though greater ranges are attained when the G5 is fired at higher altitude. The other three projectiles are illuminating, smoke and white phosphorus. To operate with the G5 South Africa has developed a complete fire-control system including a muzzle-velocity measuring device, AS 80 artillery fire-control system with a 16-bit mini-computer, S700 meteorological ground station and a complete range of communications equipment. South Africa has also developed a 155-mm (6.1-in) self-propelled howitzer (6×6) called the **G6**, which has an ordnance based on the G5 and uses the same ammunition, but this has yet to enter production.

Three G5 155-mm gun/howitzers of the South African Army in the firing position. The G5 is normally towed by a SAMIL 100 (6×6) 10-tonne truck that also carries the gun crew and its ammunition. The G5 has an exceptionally long range.

Specification

G5 gun/howitzer
Calibre: 155 mm (6.1 in)
Weight: travelling 13500 kg (29,762 lb)
Dimensions: length, travelling 9.10 m (29 ft 10.25 in); width, travelling 2.50 m (8 ft 2.4 in); height, travelling 2.30 m (7 ft 6.55 in)
Elevation: +73°/−3°
Traverse: total 84° (see text)
Maximum range: with standard ammunition 30000 m (32,810 yards) and with base-bleed projectile 37000 m (40,465 yards)

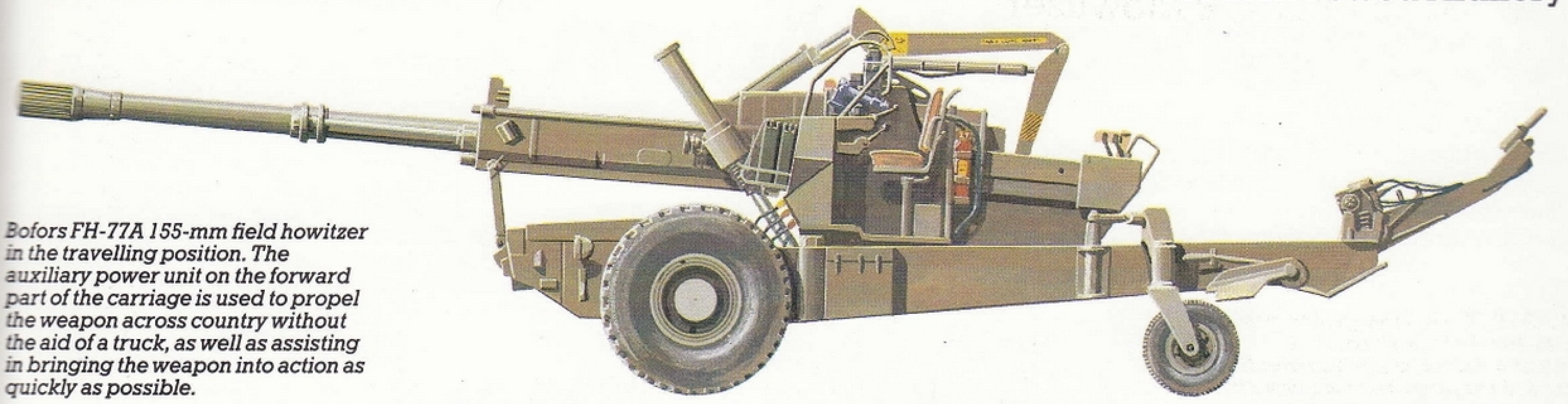
SWEDEN

Bofors FH-77A 155-mm field howitzer

In the late 1960s the Swedish army carried out a series of studies to determine its future artillery requirements, and finally decided to develop a new 155-mm (6.1-in) towed weapon that would have superior cross-country performance, a high rate of fire, good range and fire more effective ammunition. At that time Bofors was building the 155-mm (6.1-in) Bandkanon 1A self-propelled gun, which is fully armoured and has a high rate of fire as it is fitted with an automatic loader for 16 rounds of ready-use ammunition. Its main drawback, however, was and is its size and weight (53 tonnes), which limit its movement in certain parts of Sweden as well as making it difficult to conceal.

Bofors was awarded the development contract for the new towed weapon, which subsequently became known as the **FH-77A** 155-mm (6.1-in) field howitzer, for which the first orders were placed by the Swedish army in 1975.

The FH-77A has a barrel 5.89 m (19 ft 3.9 in) long and fitted with a pepperpot muzzle brake and a vertical sliding breech mechanism. The split-trail carriage has an auxiliary power unit mounted on the front, enabling the FH-77A to propel itself on roads and across country. The equipment is normally towed by a Saab-Scania SBAT 111S (6×6) truck, which also carries ammunition in pallets and the six man crew consisting of commander, gunner, two ammunition handlers, loader and crane handler. When the truck and the FH-77A encounter very rough country the main wheels of the howitzer can be engaged from the cab of the truck, so giving an 8×6 combination and a maximum speed of 8 km/h (5 mph). When this speed is exceeded the main wheels of the FH-77A are disengaged. Elevation and traverse of the FH-77A is hydraulic, though manual controls are provided for emergency use. Mounted on the right side of FH-77A is the loading tray, on which clips of three projectiles can be placed. A typical firing sequence is that the cartridge case is placed on the loading tray followed by the projectile, which is fed from the loading table. When the projectile has slipped down into the neck of the cartridge case the projectile and charge are rammed, the breech is closed and the weapon is fired. Using this method three rounds can be fired in six to eight seconds. In the sustained-fire role six rounds can be fired every other minute for 20



Bofors FH-77A 155-mm field howitzer in the travelling position. The auxiliary power unit on the forward part of the carriage is used to propel the weapon across country without the aid of a truck, as well as assisting in bringing the weapon into action as quickly as possible.

minutes.

The Bofors-developed M/77 projectile weighs 42.4 kg (93.5 lb), has a muzzle velocity of 774 m (2,540 ft) per second and goes out to a maximum range of 22000 m (24,060 yards). It is believed that Bofors is currently developing a base-bleed projectile which will have a maximum range of between 27000 and 30000 m (29,530 and 32,810 yards). For the export market Bofors has developed the **FH-77B** with a slightly longer barrel, increased elevation of +70°, mechanized loading system and a number of other major improvements. The FH-77B has already been ordered by Nigeria. To meet the requirements of the Swedish coastal artillery Bofors has developed the **Karin**, which is essentially the carriage of the FH-77A fitted with a 120-mm (4.72-in) ordnance; this is now in series production.

Specification

Bofors FH-77A field howitzer

Calibre: 155 mm (6.1 in)

Weight: travelling 11500 kg (25,353 lb)

Dimensions: length, travelling 11.60 m (38 ft 0.7 in); width, travelling 2.64 m (8 ft 8 in); height, travelling 2.75 m (9 ft 0.25 in)

Elevation: +50°/+3°

Traverse: total 50°

Maximum range: 20000 m (21,870 yards)

Bofors FH-77A 155-mm field howitzer in the firing position with two ammunition members preparing to load charges. The first three projectiles can be fired in between six and eight seconds, with the loading tray on the right side of the carriage holding the three projectiles. The more recent FH-77B is now in production for Nigeria.

USA

M102 105-mm howitzer

For many years the standard 105-mm (4.13-in) howitzer of the US Army was the M1, which was developed in the 1930s and finally standardized as the M2 in 1940. A total of 10,202 such weapons had been built by the time production ended in 1953. In the post-war period the weapon was redesignated the M101. The main drawback of the M101, which in 1948 was still in use in some 60 countries, was its weight of 2030 to 2258 kg (4,475 to 4,978 lb) depending on the model, and the lack of all-round traverse.

In 1955 a requirement was issued for a new 105-mm (4.13-in) howitzer which would fire the same range of ammunition and yet be lighter than the M101. Rock Island Arsenal designed a new weapon under the designation **XM102**, the first prototype being completed in 1962. Following trials the weapon was classified as standard A in the following year, and designated **M102**. First production M102s were completed in January 1964 and several months later the weapon was deployed to South Vietnam. After so short a development period problems were inevitably encountered with early M102s, but these were soon rectified. The M102 is issued on the scale of 18 per battalion, each battery having six weapons. Today the M102 is used mainly by airborne and airmobile divisions, to whom weight rather than range is important. The M102 is also used by Brazil, Saudi Arabia, Kampuchea, South Korea and Vietnam.

The M102 consists of four main components, namely the M137 cannon, M37 recoil system, M31 carriage, and the fire-control equipment. The M137 cannon has a vertical sliding-wedge breech mechanism, but is not fitted with a muzzle brake. The recoil system is hydropneumatic and variable, so eliminating the need for a recoil pit. The most unusual feature of the M102 is the two-wheel box-type carriage, which is constructed of aluminium. When the weapon is deployed in the firing position, a circular baseplate is lowered to the ground under the forward part of the base and the two rubber-tyred road wheels are lifted clear of the ground. A roller located at the rear of the trial assembly allows the complete carriage to be traversed through 360°. This proved to be of considerable use in Vietnam, where M102s had to engage targets in different directions at

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Specification

M102 howitzer

Calibre: 105 mm (4.13 in)

Weight: firing and travelling 1496 kg (3,300 lb)

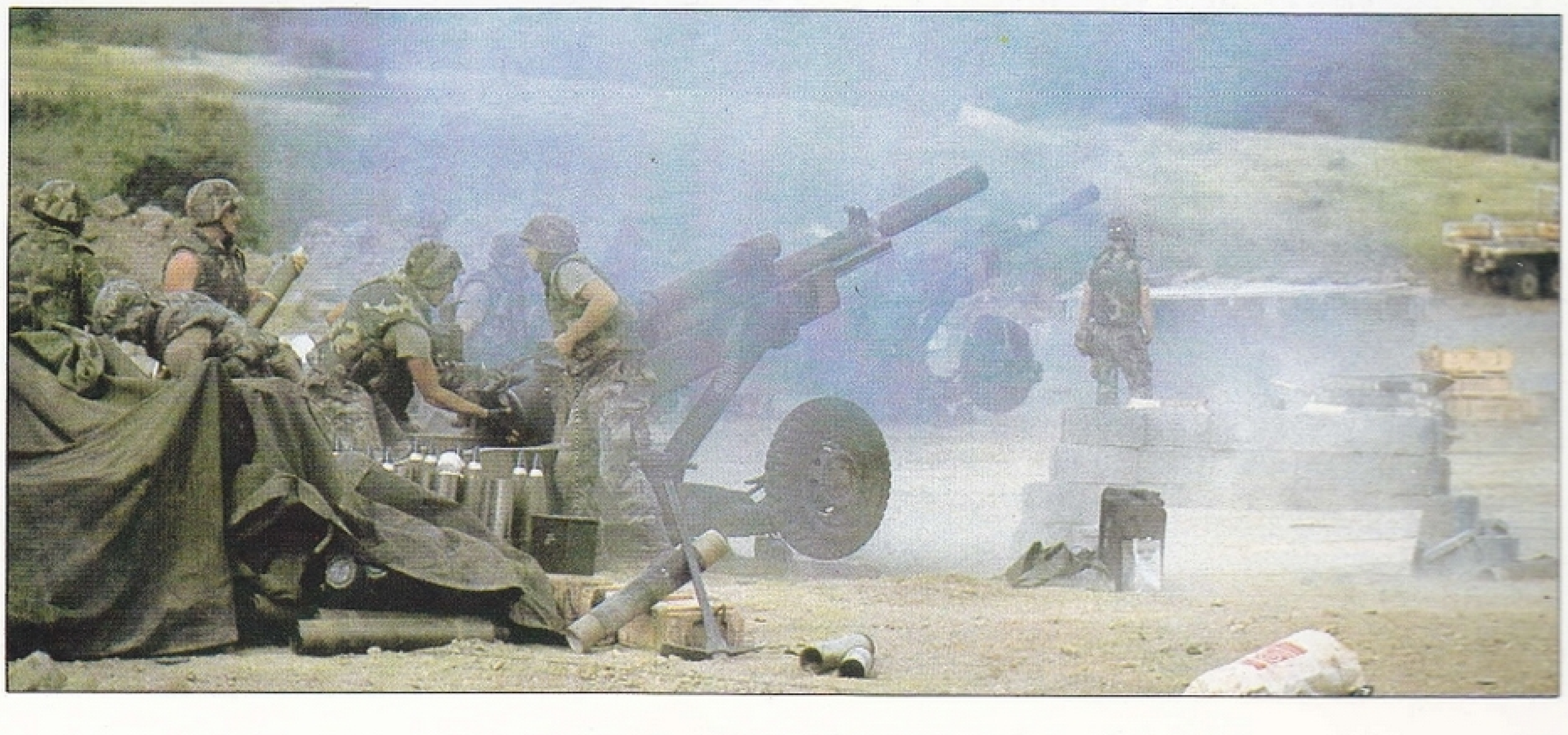
Dimensions: length, travelling 5.182 m (17 ft 0 in); width, travelling 1.964 m (6 ft 5.25 in); height, travelling 1.594 m (5 ft 2.75 in)

Elevation: +75°/−5°

Traverse: total 360°

Maximum range: with M1 ammunition 11500 m (12,575 yards) or with M548 HERA 15100 m (16,515 yards)

An M102 105-mm light howitzer of the American 82nd Airborne Division in action during the invasion of Grenada in 1983.



Copperhead in Action

Conventional artillery is not capable of attaining pinpoint accuracy – and, unfortunately, this is what is needed to stop a tank. NATO planners have had therefore to devise methods of increasing anti-armour potential in the face of the massive armoured power of the Soviet forces in Germany.

The scene is somewhere in West Germany, with several battalions of Soviet tanks advancing with the support of BMP mechanized infantry combat vehicles and the protection of ZSU-23-4 self-propelled anti-aircraft gun systems. As it is summer there is little or no cloud, and to the immediate front of the Soviet vehicles there are no known allied units in any strength. Suddenly, and without warning, six T-72 tanks are hit and grind to a halt, belching smoke and flame. The ZSU-23-4s are scanning the skies but there is no sign of enemy aircraft or helicopters. On the ground there is no tell-tale sign of smoke from allied ATGWs fired at the approaching tanks. A few seconds later another few tanks and BMPs are hit, as are some of the essential command vehicles. With these losses the tanks start to lay a smoke screen and head for the nearest cover. But this takes time for the several hundred armoured vehicles, and within 10 minutes the ground is littered with burning vehicles. The Copperhead had accomplished its mission, blunting the attack for at least a time.

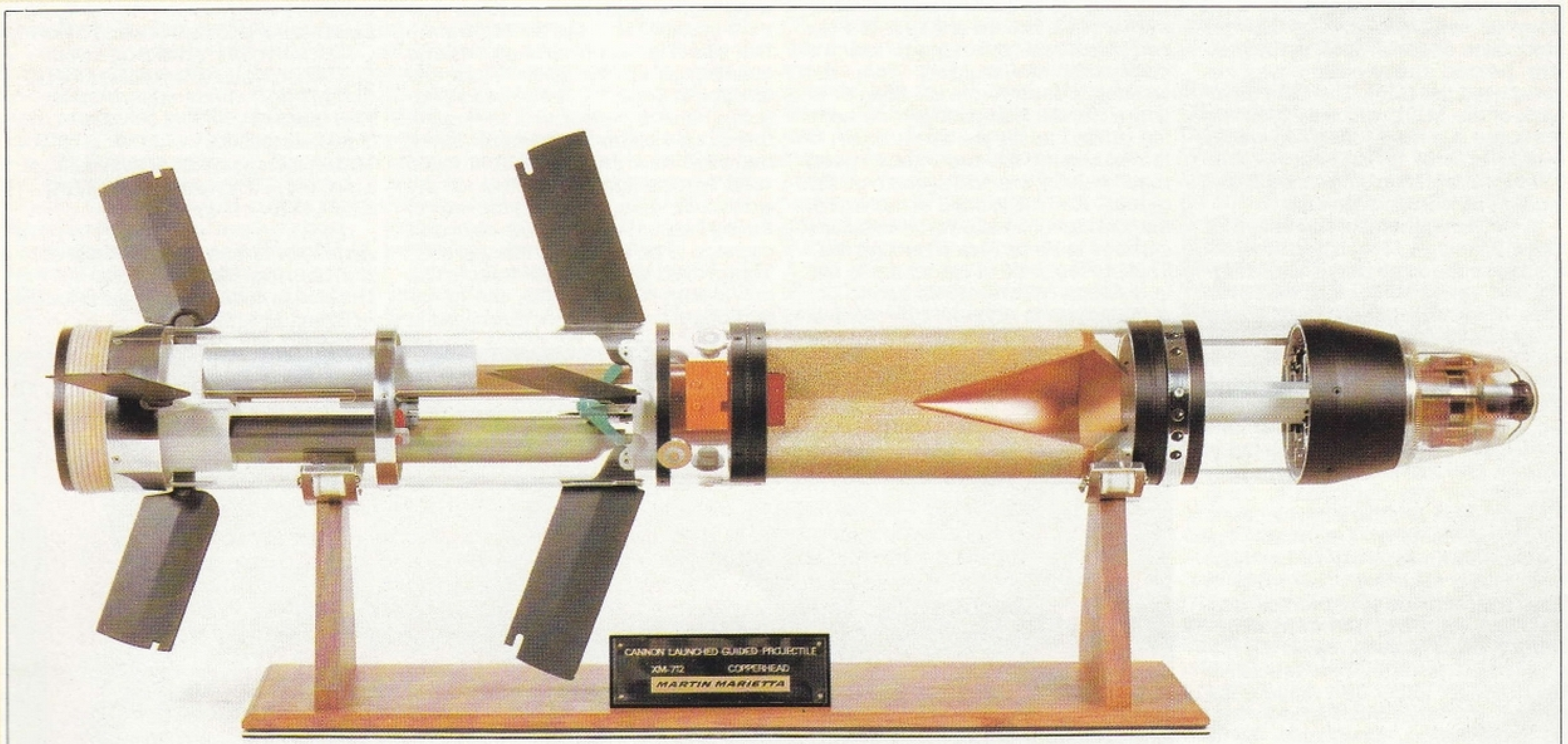
For many years 155-mm (6.1-in) artillery systems in NATO (such as the M109 self-propelled howitzer, and the M198 and FH-70 towed weapons) had little or no capability of engaging armoured vehicles at long range, except for firing RAAMS or ADAM projectiles: the Remote Area Anti-Armor Mine System (RAAMS) projectile contains nine anti-tank mines, while the Area-Denial Artillery Munition (ADAM) projectile contains 36 anti-personnel mines. Even with RAAMS a lot of projectiles have to be fired to cover a given area, and it is difficult to know exactly how effective the mines have been.

In 1970 the US Army's Rodman Laboratories conceived the idea of a Cannon-Launched Guided Projectile (CLGP) which could be fired against enemy armoured vehicles from any standard 155-mm (6.1-in) artillery system. Over the next two years feasibility studies on the CLGP were carried out not only by the Rodman Laboratories, Picatinny Arsenal, but also by the US Naval Weapons Laboratory at Dahlgren, near Washington. Following these studies a decision was taken to award contracts to two separate companies, each of which was to build prototype projectiles for comparative trials. In 1972 Martin Marietta and Texas Instruments each fired 12 prototype projectiles from an unmodified M109A1 at a variety of targets, the first company achieving eight hits and the second only one. Martin Marietta was then selected to carry out full development of the Cannon-Launched Guided Projectile (CLGP), which was designated the XM712, although today it is more commonly known as the Copperhead. Under the terms of a $45 million contract awarded in 1975 Martin Marietta carried out a number of modifications to the CLGP to extend its range and improve the effectiveness of its HEAT (High Explosive Anti-Tank) warhead, and built 350 pre-production units. Once firing trials of these munitions got under way, a number of faults became apparent, it proving difficult to make Copperhead on a production line basis as the original prototypes had been virtually hand-built. Eventually these problems were overcome and volume production started at Martin Marietta's facility in Florida. Meanwhile Congress was becoming increasingly concerned about Copperhead, not only on cost grounds but also on reliability and its operational value in a European environment, which is quite different to that on the test ranges in the USA, especially that at White Sands Missile Range. In 1982 Congress rejected both the US Army's request for 7,629 projectiles and the US Marine Corps' request for 791 projectiles at a total cost of some $200 million, for during a previous 75-round reliability demonstration only a 67 per cent success rate was achieved after 45 rounds had been fired, the trial being halted at that stage. The requirement demanded a success rate of 70 per cent. Most of the problems were traced to quality control and were soon rectified, and in later trials the success rate was over 85 per cent.

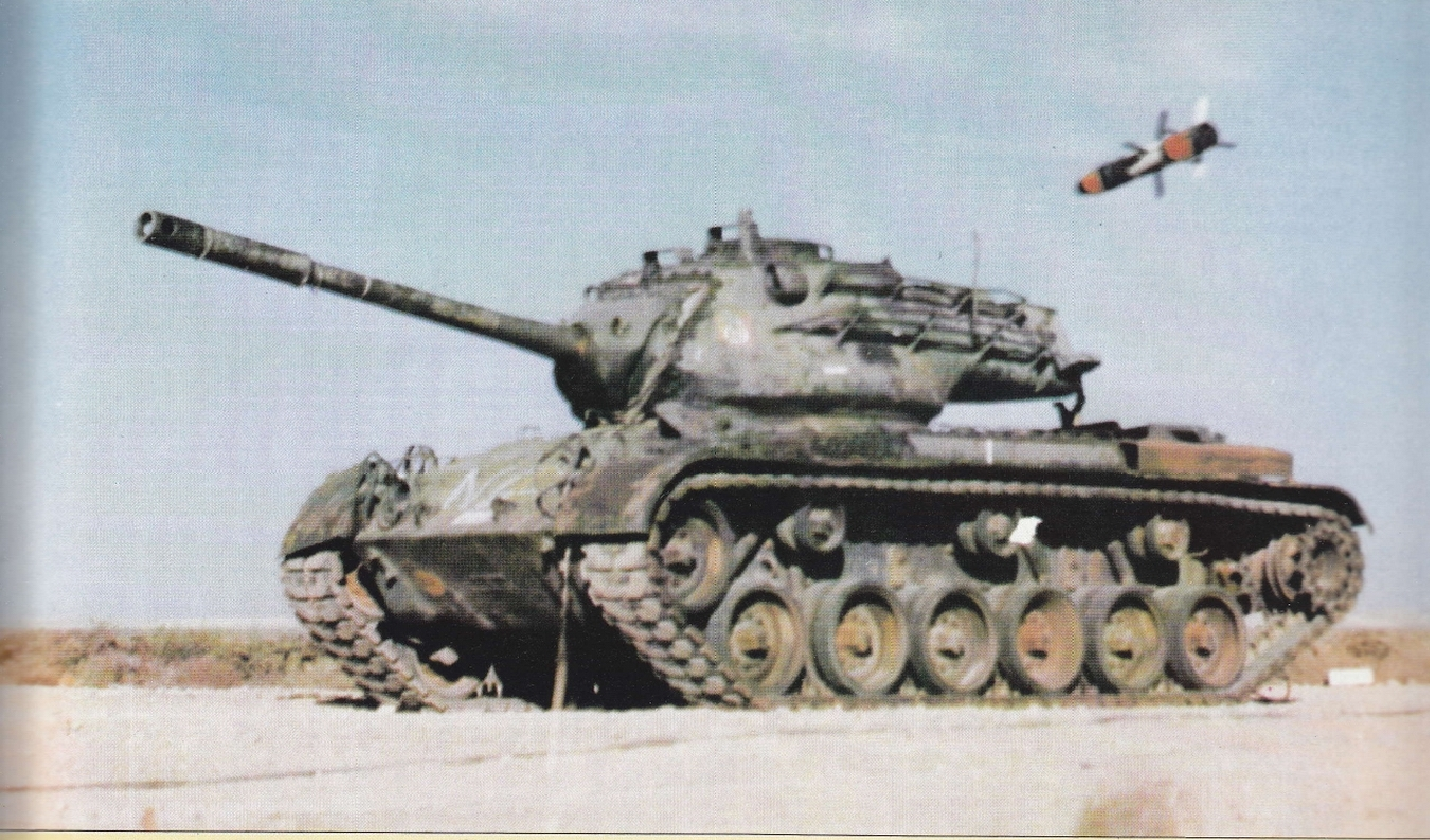
Copperhead is part of a system which includes not only the projectile but also a laser designator on the ground, or mounted in a vehicle, or located in a helicopter or RPV.

The Copperhead projectile

The Copperhead projectile is loaded into the weapon in a manner similar to a conventional projectile, the charge loaded, the breech closed and the weapon fired. The projectile itself consists of three sections: from nose to tail these are the guidance, the warhead, and the stabilization and control sections. The nose-



This cutaway model of an early Copperhead Cannon-Launched Guided Projectile shows fins at the rear and wings in the deployed position. The High Explosive Anti-Tank (HEAT) warhead is towards the nose of the Copperhead, and is able to penetrate any tank armour in service today.



mounted guidance section houses the seeker and other electronic assemblies and has holes to allow the HEAT warhead to pass through without degrading its performance. The HEAT warhead will, according to Martin Marietta, penetrate the armour of all tanks in service today, including that of the T-72. Often the Copperhead will be expected to strike the tank at one of its weakest points, such as its top or hull sides. The stabilization and control section at the rear also has extendable wings and extendable fins at the very rear, the former being added early in development to increase the operational range of the Copperhead.

In the US Army it is probable that each M109A1/M109A2 self-propelled howitzer willl always carry two Copperhead Cannon-Launched Guided Projectiles. The projectile can also be fired from the French 155-mm (6.1-in) GCT and SP-70 (not yet in service) self-propelled weapons, as well as the towed 155-mm (6.1-in) M198, FH-70 and M114A2.

Associated designators

The target of the Copperhead has to be designated by a laser system such as the Hughes Ground Laser Locator Designator (GLLD), Hughes Laser Target Designator (LTD) and Hughes Modular Universal Laser Equipment (MULE), the last being developed to meet the requirements of the US Marine Corps. The British Ferranti Laser Target Marker and Ranger (LTMR) can also be used to designate Copperhead; this equipment has been in service with the British army for some time, and was used operationally in the Falklands campaign of 1982 to guide Paveway laser-guided bombs dropped from BAe Harrier aircraft of the Royal Air Force to knock out point targets. Targets for Copperhead can also be designated by the Lockheed Aquila remotely-piloted vehicle (RPV) and even the Hughes Helicopters Advanced Attack Helicopter (AAH) fitted with the nose-mounted Martin Marietta-developed Target Acquisition and Designation System. The Emerson Improved TOW Vehicle (ITV), of which several thousands have already been built for the US Army and many export customers, can also be fitted with a laser designator. More recently Martin Marietta has developed the Tadpole system, which is basically a M113 armoured personnel carrier with, on its roof, a hydraulically-operated mast carrying a pod with a laser rangefinder/designator and a TV system for both target-acquisition and designation purposes.

It is envisaged that in a typical target engagement the forward observer detects the enemy vehicles and, when they are within range of the artillery system, alerts the M109A1s for a Copperhead engagement. While the artillerymen are loading Copperhead the forward observer relays the approximate position of the target to the M109, which is then fired. Once the projectile has been fired, the fins at the rear of Copperhead are deployed to provide stabilization and then, at a pre-set time, the forward wings are deployed and the guidance system is switched on. Towards the end of the flight the ground observer designates the target with his laser beam and the Copperhead's electro-optical seeker locks onto the target and finally impacts. The ground observer leaves laser designation as late as possible, for systems are already available, that enable the source of the laser illumination to be detected and so neutralized by suppressive fire. Vehicles in close proximity can be illuminated by different lasers as the latter have codes which can be changed, so that two Copperheads will not hit the same target. The Copperhead weighs 63.5 kg (140 lb) and has a maximum range of 20000 m (21,875 yards), And during early trials targets were successfully engaged at ranges of 4000, 8000, 12000 and 14000 m (4,375, 8,750, 13,125 and 15,310 yards). In some cases the targets were head on, while in others they were moving or stationary.

This Martin Marietta Copperhead Cannon-Launched Guided Projectile is about to strike a M47 target tank during early trials at the White Sands Missile Range in Mexico.

The main criticism that has been levelled at Copperhead is that for much of the year in a European environment Copperhead would be ineffective because of cloud, mist and fog, which prevent laser designation, although the manufacturer says that Copperhead is sufficiently manoeuvrable to seek out targets during bad weather and low cloud. If the Soviets ever decide to invade Western Europe they will probably launch their attack at night and in the worst possible weather.

At one time there was much talk of a NATO consortium to produce Copperhead under licence in Europe, but this seems to have been delayed for the time being at least. Diehl of West Germany and Martin Marietta of the United States formed a new European-based company called PGM Systems to act as the development agency for Copperhead in Europe, and partners in this would be Marconi Space and Defence Systems in the UK, Selenia in Italy, Signaal in The Netherlands, GSG in Belgium and another partner in Greece.

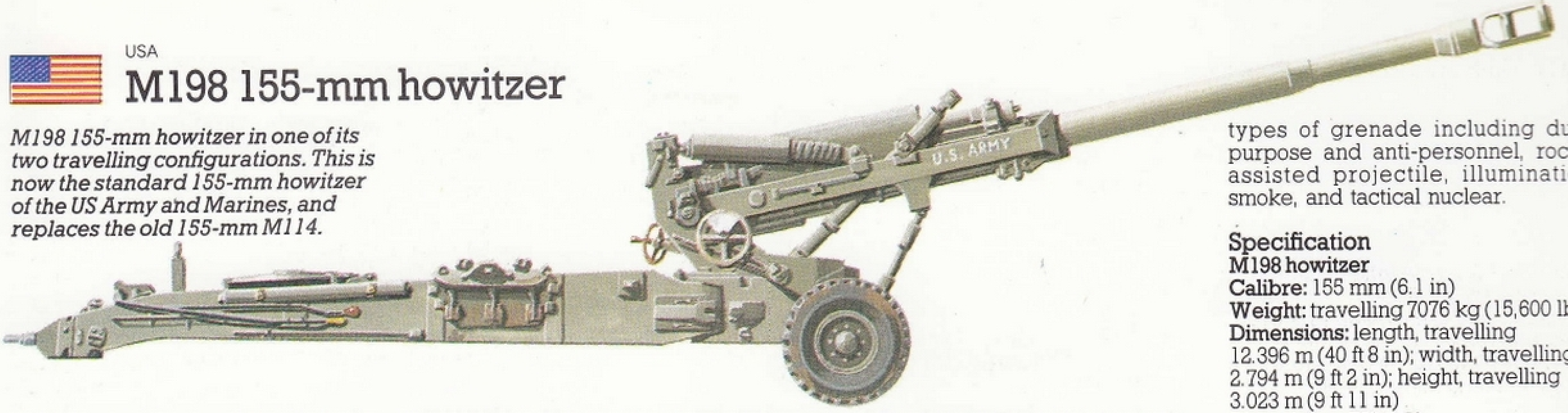
Future systems

Although Copperhead has only recently been introduced into service with the US Army (and has not so far been purchased by any other country), work is already under way on even more advanced systems in 203-mm (8-in) calibre for the self-propelled M110A2. These include the Extended-Range Guided Projectile (ERGP) and the Advanced Indirect Fire System (AIFS), which would have a range of some 70 km (43.5 miles). Whether or not any part of these complex and expensive systems will enter production and service is still uncertain.

USA

M198 155-mm howitzer

M198 155-mm howitzer in one of its two travelling configurations. This is now the standard 155-mm howitzer of the US Army and Marines, and replaces the old 155-mm M114.



For many years the standard 155-mm (6.1-in) towed howitzer of the US Army was the M114, which was developed in the 1930s and standardized as the M1 in 1941. By the end of World War II some 6,000 had been built, and in the post-war period the weapon was redesignated M114. Like the 105-mm (4.13-in) M101 towed howitzer, the M114 suffered the major drawback of having a limited range and traverse. Following the issue of a formal requirement for a new 155-mm (6.1-in) howitzer, Rock Island Arsenal started design work in 1968, its first development prototype being completed two years later. A total of 10 prototypes was built under the designation **XM198**, and after trials and the usual modifications it was adopted as the 155-mm (6.1-in) howitzer **M198**. Production started at Rock Island Arsenal in 1978, with the first battalion of 18 M198s forming at Fort Bragg in the following year. Each battalion has three batteries each with six M198s.

In addition to being used by the US Army and US Marine Corps, the M198 has also been ordered by Australia (36 to replace the British 140-mm/5.5-in gun) and a number of other countries, notably in the Middle East. In the US Army and US Marine Corps the M198 is towed by a 5-ton (6×6) truck which also carries the ammunition and 11-man crew, although the weapon can be towed by a variety of other tracked and wheeled vehicles. It is airportable, and can be carried slung underneath Boeing Vertol CH-47 and Sikorsky CH-53 helicopters. The M198 is normally issued to US infantry, airborne and air assault divisions, while the mechanized infantry and armoured divisions have the 155-mm (6.1-in) M109 self-propelled howitzer. The M198 was first used operationally by the US Marines in the Lebanon in 1983.

Main components of the M198 are the carriage, recoil system, fire-control equipment, and cannon (or ordnance, as the British prefer to call it). The carriage is of the split-trail type and fitted with a two-position rigid suspension. When the weapon is in the firing position, a firing platform is lowered to the ground under the forward part of the carriage and the wheels are raised clear of the ground. The cradle has the elevation and traverse system, while the top carriage has the assembly cradle, equilibrators and recoil guides. The recoil mechanism is of the hydropneumatic type with a variable recoil length. The M199 cannon has a double-baffle muzzle brake, thermal warning device and a screw-type breech mechanism. Fire-control equipment includes an M137 panoramic telescope, two elevation quadrants and an M138 elbow telescope.

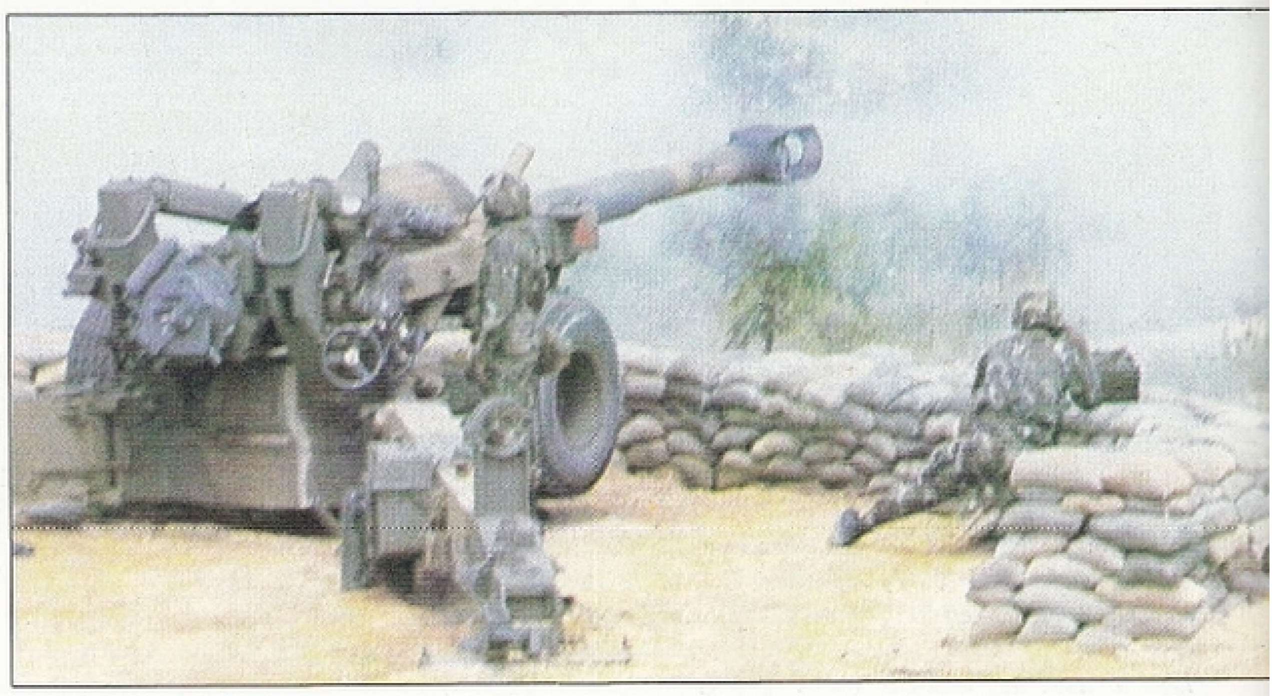
When in the travelling position the ordnance is normally traversed to the rear and locked in position over the trails. Unlike the new French 155-mm (6.1-in) towed guns, British/West German/Italian FH-70 and the Swedish FH-77A, the M198 does not have an auxiliary power unit to enable it to be moved under its own power.

Ammunition is of the separate-loading type and includes Agent, anti-tank (carrying mines), Cannon-Launched Guided Projectile, high explosive, high explosive with various types of grenade including dual-purpose and anti-personnel, rocket assisted projectile, illumination, smoke, and tactical nuclear.

Specification

M198 howitzer
Calibre: 155 mm (6.1 in)
Weight: travelling 7076 kg (15,600 lb)
Dimensions: length, travelling 12.396 m (40 ft 8 in); width, travelling 2.794 m (9 ft 2 in); height, travelling 3.023 m (9 ft 11 in)
Elevation: +72°/−5°
Traverse: total 45°
Maximum range: with M107 projectile 18150 m (19,850 yards) and with rocket-assisted projectile 30000 m (32,810 yards)

M198 155-mm howitzer in static fire position, with sand bags providing some form of protection. This weapon was first used in combat during the recent fighting in Lebanon. It is also used by a number of other countries.



USSR

D-30 122-mm howitzer

The **D-30** 122-mm (4.8-in) howitzer was designed by the F.F. Petrov design bureau at Artillery Plant Number 9 at Sverdlovsk as the replacement for the 122-mm (4.8-in) M1938 (M-30)) howitzer which had been introduced into the Soviet army shortly before World War II. The D-30 entered service with the Soviet army in the early 1960s and has a number of significant advantages over the weapon it replaced, including a range of 15400 compared with 11800 m (16,840 compared with 12,905 yards) and a traverse of 360° compared with 49°. In addition to being used by the Soviet army, the weapon is in service with well over 30 countries, and has seen widespread use in the Middle East, Africa and the Far East. The more recent 122-mm (4.8-in) **M-1974** self-propelled howitzer has an ordnance based on the D-30. Another SP mounting was evolved some years ago, when Syria was short of self-propelled artillery and installed a number of D-30 ordnances on obsolete T-34/85 tank chassis. Under contract to the Egyptian government the Royal Ordnance Factory Leeds (where the Chieftain, Challenger and Khalid tanks are built) is fitting the D-30 howitzer onto the chassis of the Combat Engineer Tractor for the Egyptian army.

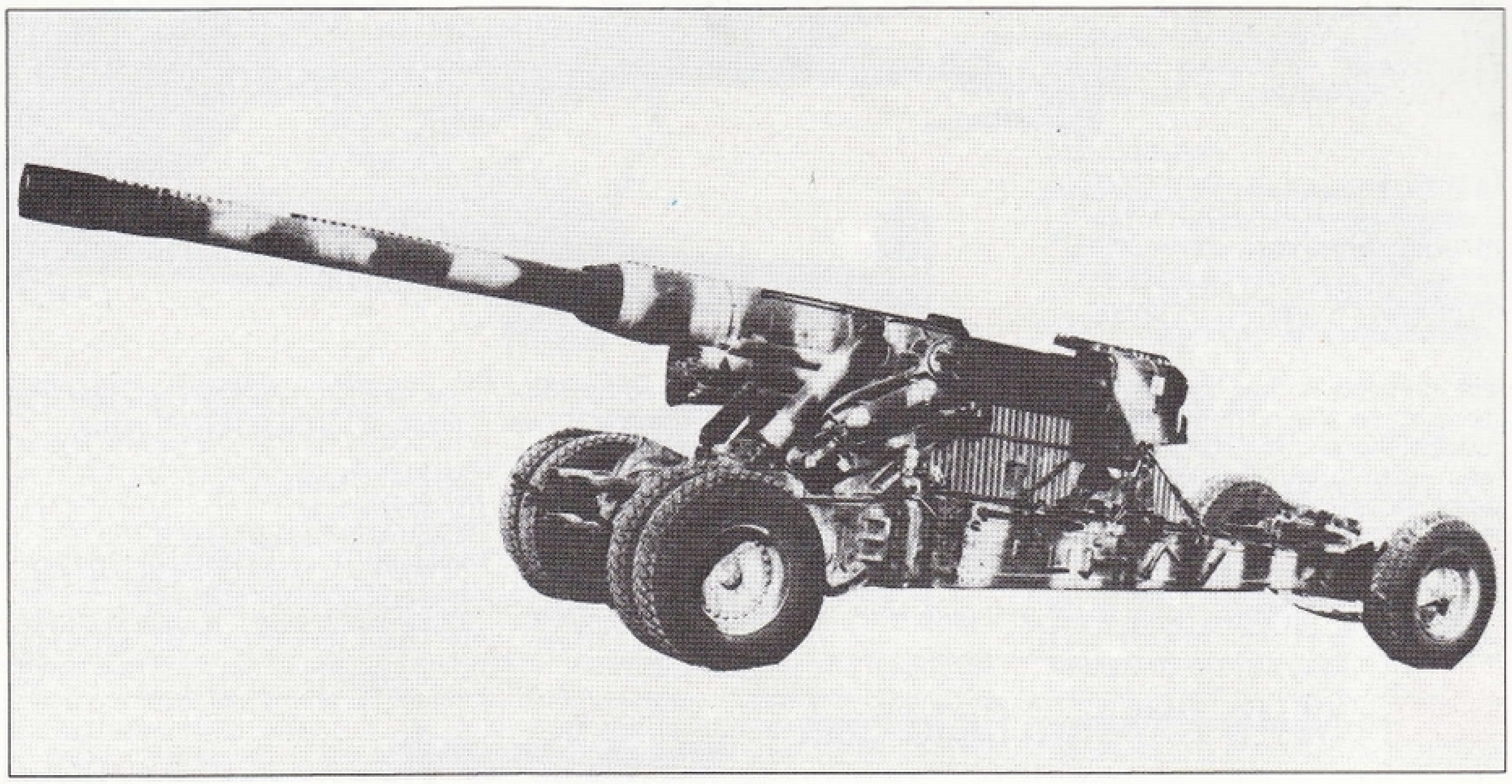
In the Soviet army the D-30 is issued on the scale of 36 per tank divisions (one artillery regiment with two battalions of 18 weapons, each battalion having three batteries of six D-30s), and each motorized rifle division has 72 D-30s (each motorized rifle regiment having a battalion of 18 D-30s and the artillery regiment two 18-gun battalions). More recently it is believed that the Soviets, like some members of NATO, are increasing the number of guns in the battery from six to eight: each battalion would thus now have 24 instead of 18 D-30s.

The D-30 has a 4.875-m (16-ft) barrel fitted with a multi-baffle muzzle brake and a semi-automatic vertical sliding-wedge breech mechanism, the recoil system being mounted over the ordnance. The weapon is towed muzzle first, the three trails being clamped in position under the ordnance. On arrival at the pre-determined firing position the crew must first unlock the barrel travel lock, which then folds back onto the central trail. The firing jack under

Three Soviet D-30 122-mm howitzers in the firing position. For many years the D-30 was the backbone of Soviet artillery regiments, but is now being replaced by the 122-mm M-1974 self-propelled howitzer. It has been supplied to almost every country receiving Soviet aid.

USSR

S-23 180-mm gun



S-23 180-mm gun in travelling configuration with the dolly attached to the rear. For many years this was thought to be a 203-mm weapon, but examination of weapons captured by Israel showed that it was in fact 180 mm in calibre.

For some 30 years this weapon has been able to outrange virtually all NATO towed and self-propelled artillery weapons. It was first seen in public during a 1955 Moscow parade, and for many years was known as the 203-mm (8-in) **M-1955** gun/howitzer in the West. It is believed to have entered service several years before 1955 and to be a development of a naval weapon. During the Middle East war of 1973 a number of these weapons were captured by Israel and then taken back to Israel for detailed evaluation by intelligence personnel. It was then discovered that the actual calibre of the weapon was 180 mm (7.09 in) and that its correct Soviet designation is **S-23**. In the Soviet army the S-23 is issued on the scale of 12 weapons in the heavy artillery brigade of every artillery division. More recent information has shown that the artillery division in the Soviet Union no longer has S-23s and now consists of a headquarters, anti-tank regiment with 36 T-12 or T-12A towed anti-tank guns, multiple rocket-launcher brigade with four battalions of BM-27 (8×8) multiple rocket-launchers (total of 72 launchers), target-acquisition battalion, signal company, motor transport battalion, two regiments of 130-mm (5.1-in) M-46 field guns (total of 108 equipments) and two regiments of 152-mm (6-in) D-20 gun/howitzers or the new M-1973 self-propelled gun/howitzer (total of 108 equipments).

The S-23 is known to be in service with a number of other countries including Egypt, India and Syria, and unconfirmed reports have added Cuba, Ethiopia, North Korea, Libya, Mongolia and Somalia. The weapon is normally towed by an AT-T heavy tracked artillery tractor, which also carries the 16-man crew and a small quantity of ammunition.

The S-23 has a barrel some 8.8 m (28 ft 10.46 in) long with a pepperpot muzzle brake, the recoil system under the barrel and a screw breech mechanism. To reduce the overall length of the weapon for travelling the barrel can be withdrawn out of battery to the rear and linked to the trails. The carriage is of the split-trail type, with to twin rubber-tyred road wheel units at the front and a two-wheel dolly at the rear.

The S-23 fires a bag-type variable-charge separate-loading HE projectile designated OF-43 (weighing some 84.09 kg/185.4 lb with a maximum muzzle velocity of 790 m/2,590 ft per second) as well as a G-572 concrete-piercing projectile (weighing 97.7 kg/215.4 lb) and a 0.2-kiloton tactical nuclear projectile. After the weapon had been in service for some time an HE rocket-assisted projectile was introduced: with a muzzle velocity of 850 m (2,790 ft) per second this has a maximum range of 43800 m (47,900 yards) compared with 30400 m (33,245 yards) for the original projectile. Because of the heavy weight of the projectile the S-23 has a relative slow rate of fire (one round per minute), dropping to one round every two minutes in the sustained fire role.

Specification

S-23 gun

Calibre: 180 mm (7.09 in)

Weight: in action 21450 kg (47,288 lb)

Dimensions: length, travelling 10.485 m (34 ft 4.8 in); width, travelling 2.996 m (9 ft 9.95 in); height, travelling 2.621 m (8 ft 7.2 in)

Elevation: +50°/−2°

Traverse: 44°

Maximum range: with HE projectile 30400 m (33,245 yards) and with rocket-assisted projectile 43,800 m (47,900 yards)

YUGOSLAVIA

M-56 105-mm howitzer

With the German surrender in Yugoslavia at the end of World War II, large quantities of German artillery were abandoned and much of this was taken over by the Yugoslav army. Even today, some 40 years later, numbers of German 88-mm (3.46-in) guns are still in service in the coastal-defence role, while the 105-mm (4.13-in) towed M18, M18M and M18/40 howitzers are known to be used by reserve units. In the immediate post-war period the United States supplied Yugoslavia with considerable amounts of towed artillery, including 155-mm (6.1-in) M114 and 105-mm (4.13-in) M101 howitzers, and 155-mm (6.1-in) M59 'Long Tom' guns. These remain in service today, as does a copy of the M114 called the M-65. More recently Yugoslavia has designed and built two weapons to meet her own requirements, these being the 105-mm (4.13-in) howitzer **M-56** and a 76-mm (3-in) mountain gun M-46, the latter developed to meet the specific requirements of Yugoslav mountain units.

The M-56 has a barrel 3.48 m (11 ft 5 in) long with a multi-baffle muzzle brake, a hydraulic recoil buffer and hydropneumatic recuperator above and below the barrel, and a horizontal sliding-wedge breech mechanism. The carriage is of the split-trail type, with a spade attached to each end of the pole-type trail. The M-56 has a split shield that slopes to the rear and sides. Some carriages have been observed with American type road wheels and tyres similar to that fitted to the M101, which allows the weapon to be towed up to 70 km/h (43.5 mph), while others have wheels with solid tyres similar to that fitted to the German 105-mm (4.13-in) howitzers of World War II. When the latter are fitted the weapon cannot be towed at high speed.

Fire-control equipment consists of a panoramic telescope with a magnification of ×4, a direct-fire anti-tank telescope with a magnification of ×2, and a gunner's quadrant.

Ammunition is of the semi-fixed type (e.g. projectile and a cartridge case containing the bagged charge). The following projectiles can be fired at a maximum rate of 16 rounds per minute for a short period: HE projectile weighing 15 kg (33.1 lb) with a muzzle velocity of 570 m (1,870 ft) per second, smoke projectile weighing 15.8 kg (34.8 lb), armour-piercing tracer, and high explosive squash head tracer (HESH-T). The HESH-T projectile weighs 10 kg (22.05 lb), and when it hits an enemy armoured vehicle the 2.2 kg (4.85 lb) of explosive flattens itself against the armour before exploding, when it can penetrate up to 100 mm (3.9 in) of armour plate at an angle of 30°.

An unusual feature of the M-56 is that in an emergency it can be fired before the trails are spread, although in this case total traverse is limited to 16° and elevation to +16°. The M-56 has a crew of 11 men and is normally towed by a TAM 1500 (4×4) truck. It was thought to be in service only with the Yugoslav army, but some have been observed in El Salvador, in this instance towed by American 2½-ton (6×6) trucks.

Specification

M-56 howitzer

Calibre: 105 mm (4.13 in)

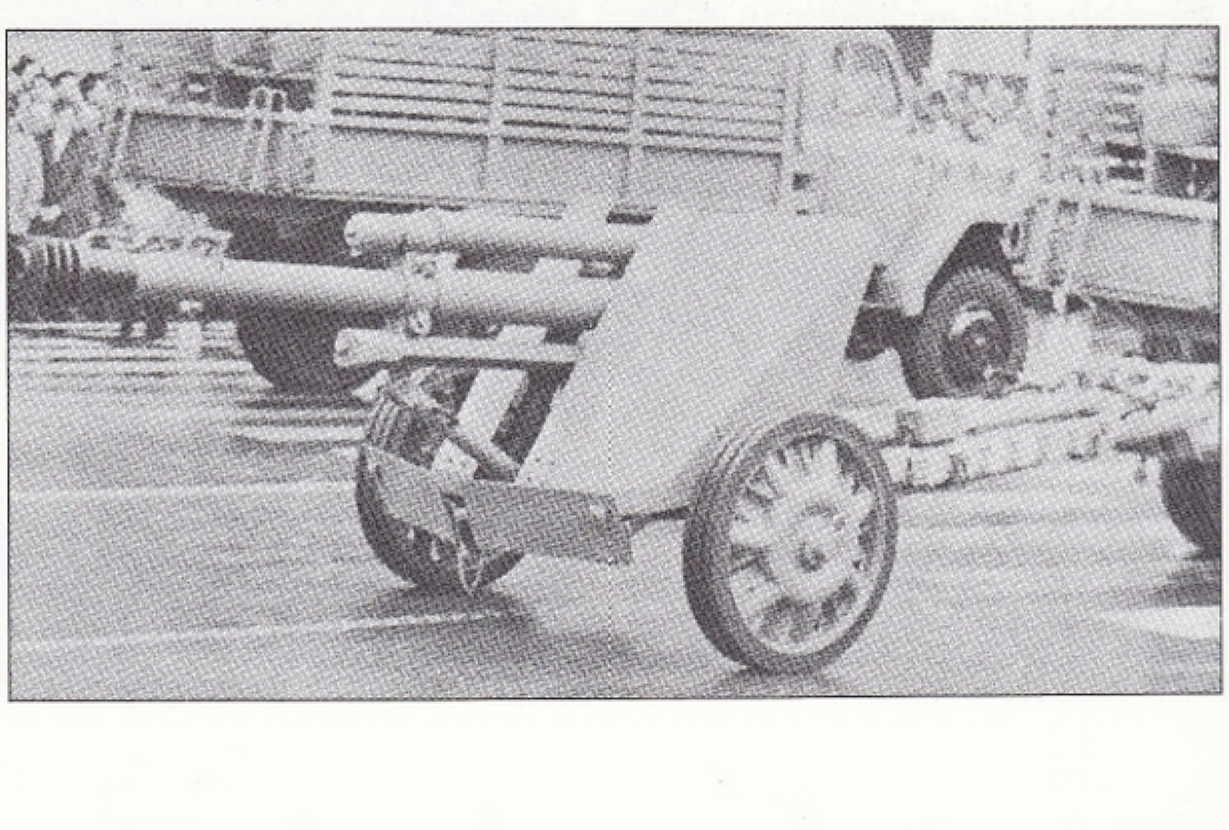
Weight: travelling 2100 kg (4,630 lb) and firing 2060 kg (4,541 lb)

Dimensions: length, travelling 6.17 m (20 ft 3 in); width, travelling 2.15 m (7 ft 0.66 in); height, travelling 1.56 m (5 ft 1.4 in)

Elevation: +68°/−12°

Traverse: total 52°

Maximum range: 13000 m (14,215 yards)



A Yugoslav M-56 105-mm howitzer in its travelling configuration. This particular model has wheels with solid rubber tyres similar to those fitted to German 105-mm howitzers also used by the Yugoslav army since World War II.

Armed Forces of the World

US Navy

Part 5

Naval research

Considerable research effort is expended on what might be termed the 'exotics', the unconventional forms of warship. Hydrodynamic laws limit the speed at which displacement hulls can be effectively driven, deck areas are never large enough for requirements, and high-power machinery is too large, too heavy or has poor economy: the naval architect works within so many constrictions that investigation of the unorthodox is often attractive.

Though, like most 'blue-water' fleets, the US Navy has little peacetime use for minor combatants such as fast attack craft (FAC), the threat posed by such craft cannot be ignored as they have been transferred liberally by the Soviets to friendly states, usually those flanking shipping lanes vital to the West. Warships need to train with the real thing to establish techniques and, for this purpose, the US Navy's six 'Pegasus' class hydrofoils (PHMs) are valuable. These are the rump of the so-called 'NATO Hydrofoil' programme from which the USA's co-partners, West Germany and Italy, retired. Foilborne, the 'Pegasus' class PHMs can reach 48 kts, about 10 kts more than the average FAC, and carry eight Harpoon SSMs, which confer probably the greatest firepower ever on a craft of the size.

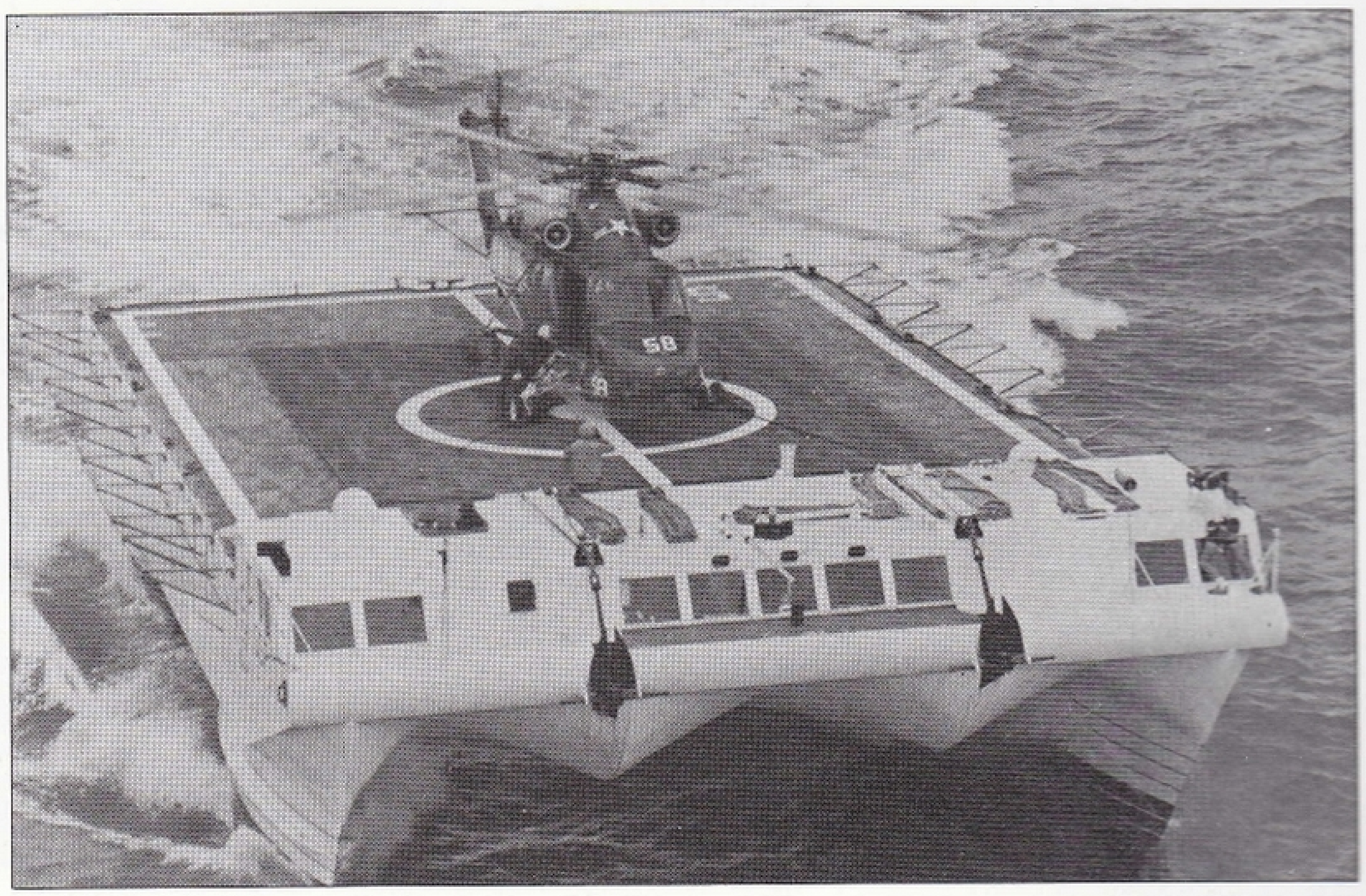
Hovercraft have been developed with imagination. Sidewall types, known as surface effect ships, were seen at one time as frigate replacements, but the planned 2,000 SES that would have explored the concept is currently shelved. Flexibly-skirted types, known as air cushion vehicles, have been developed to the extent where the new 'Whidbey Island' ships will have this type of assault landing craft as a standard fit.

Great interest is being shown in the Small Waterplane Area Twin Hull (SWATH) ship. Rather like a semi-submersible drilling rig in concept, it has a nearly square plan, its spacious deck being supported on two slim, buoyant pylons, each rising from a submerged, cylindrical hull. If successful, the concept promises better seakeeping in poor weather, and its revolutionary layout offers an excellent and stable helicopter or V/STOL platform.

Firmly wedded to steam plant, US naval engineering came late to the gas turbine and has had to make do on just the LM 2500 for far too long. This General Electric unit develops about 20,000 hp (14915 kW) and, while reliable, needs to be complemented by smaller model for a COGOG arrangement, allowing a ship to cruise economically, without incurring the penalty of the poor specific fuel consumption exhibited by gas turbines when run at speeds other than their design point. Only recently has the LM 500 come on the market for the purpose.

Diesels are disliked, as indeed they are in the Royal Navy, mainly for their noise and maintenance levels. Continental Europe, however, is the diesel stronghold and is developing the machine rapidly. If the type's drawbacks can be overcome, its known strengths of economy and flexibility may well attract American designers. Already, manufacturing licences are being taken out, and diesels are going into new auxiliaries and the 'Whidbey Island' class. There is a growing interest in the 'quiet' diesel-electric frigate and the diesel will make an excellent cruising engine for medium-sized CODOG warships. Interest is likely to grow.

On a more revolutionary note, electrical superconductivity has been attracting attention, but whether it will ever be satisfactorily harnessed to marine propulsion remains debatable. Though the prime mover itself would be compact, the power and bulk demanded by its associated cryogenics will be considerable with existing materials.



A promising development in the US Navy's research programme, the SWATH (Small Waterplane Area Twin Hull) semi-submersible promises better seakeeping in poor weather, and an excellent helicopter/VTOL platform.

SHIP BATTLE FORCES

STRATEGIC FORCES

SUBMARINES

BALLISTIC MISSILE SUBMARINES

'LAFAYETTE' CLASS
SSBN 616 *Lafayette* (Groton, Ct)
SSBN 617 *Alexander Hamilton* (Groton, Ct)
SSBN 619 *Andrew Jackson* (Groton, Ct)
SSBN 620 *John Adams* (Charleston, SC)
SSBN 622 *James Monroe* (Charleston, SC)
SSBN 623 *Nathan Hale* (Charleston, SC)
SSBN 624 *Woodrow Wilson* (Charleston, SC)
SSBN 625 *Henry Clay* (Charleston, SC)
SSBN 626 *Daniel Webster* (Groton, Ct)

'JAMES MADISON' CLASS
SSBN 627 *James Madison* (Charleston, SC)
SSBN 628 *Tecumseh* (Charleston, SC)
SSBN 629 *Daniel Boone* (Charleston, SC)
SSBN 630 *John C. Calhoun* (Charleston, Sc)
SSBN 631 *Ulysses S. Grant* (Groton, Ct)
SSBN 632 *Von Steuben* (Charleston, SC)
SSBN 633 *Casimir Pulaski* (Charleston, SC)
SSBN 634 *Stonewall Jackson* (Charleston, SC)
SSBN 635 *Sam Rayburn* (Groton, Ct)
SSBN 636 *Nathanael Greene* (Groton, Ct)

'BENJAMIN FRANKLIN' CLASS
SSBN 640 *Benjamin Franklin* (Charleston, SC)
SSBN 641 *Simon Bolivar* (Charleston, SC)
SSBN 642 *Kamehameha* (Groton, Ct)
SSBN 643 *George Bancroft* (Charleston, SC)
SSBN 644 *Lewis and Clark* (Charleston, SC)
SSBN 645 *James K. Polk* (Charleston, SC)
SSBN 654 *George C. Marshall* (Groton, Ct)
SSBN 655 *Henry L. Stimson* (Newport News, Va)
SSBN 656 *George Washington Carver* (Newport News, Va)
SSBN 657 *Francis Scott Key* (Newport News, Va)
SSBN 658 *Mariano G. Vallejo* (Charleston, SC)
SSBN 659 *Will Rogers* (Newport News, Va)

'OHIO' CLASS
SSBN 726 *Ohio* (Bangor, Wa)
SSBN 727 *Michigan* (Bangor, Wa)
SSBN 728 *Florida* (Bangor, Wa)

Showing little evidence of being deep beneath the Atlantic, the missile compartment of the Trident missile submarine USS Ohio *(SSBN 726) stretches into the distance. The vast hull of the 'Ohio' class submarines can accommodate 24 of the long Trident D5 missiles.*

12 PASS

The enormous size of the modern US carrier leads to a certain amount of difficulty in berthing. Here the large harbour tugs* Wapakoreta, Marinette *and* Dahlonega *worry at USS* John F. Kennedy *(CV 67).

MOBILE LOGISTIC SHIPS

MATERIAL SUPPORT SHIPS

'HUNLEY' CLASS
AS 31 *Hunley* (Holy Loch, Scotland)
AS 32 *Holland* (Charleston, SC)

'SIMON LAKE' CLASS
AS 33 *Simon Lake* (Kings Bay, Ga)
AS 34 *Canopus* (Charleston, SC)

SUPPORT SHIPS

OTHER AUXILIARIES

'NORWALK' CLASS
TAK 282 *Marshfield* (no home port assigned)

'VEGA' CLASS
TAK 286 *Vega* (no home port assigned)

BATTLE FORCES

AIRCRAFT CARRIERS

'MIDWAY' CLASS
CV 41 *Midway* (Yokosuka, Japan)
CV 43 *Coral Sea* (Norfolk, Va)

'FORRESTAL' CLASS
CV 60 *Saratoga* (Mayport, Fl)
CV 61 *Ranger* (San Diego, Ca)
CV 62 *Independence* (Norfolk, Va)

'KITTY HAWK' CLASS
CV 63 *Kitty Hawk* (San Diego, Ca)
CV 64 *Constellation* (Bremerton, Wa)
CV 66 *America* (Norfolk, Va)

'JOHN F. KENNEDY' CLASS
CV 67 *John F. Kennedy* (Norfolk, Va)

'ENTERPRISE' CLASS
CVN 65 *Enterprise* (Alameda, Ca)

'NIMITZ' CLASS
CVN 68 *Nimitz* (Norfolk, Va)
CVN 69 *Dwight D. Eisenhower* (Norfolk, Va)
CVN 70 *Carl Vinson* (Alameda, Ca)
71 THEODORE ROOSEVELT
72 ABRAHAM LINCOLN
73 GEORGE WASHINGTON

SURFACE COMBATANTS

BATTLESHIPS

'IOWA' CLASS
BB 62 *New Jersey* (Long Beach, Ca)

CRUISERS

'LEAHY' CLASS
CG 16 *Leahy* (San Diego, Ca)
CG 17 *Harry E. Yarnell* (Norfolk, Va)
CG 18 *Worden* (Pearl Harbor, Hi)
CG 19 *Dale* (Mayport, Fl)
CG 20 *Richmond K. Turner* (Charleston, SC)
CG 21 *Gridley* (San Diego, Ca)
CG 22 *England* (San Diego, Ca)
CG 23 *Halsey* (San Diego, Ca)
CG 24 *Reeves* (Yokosuka, Japan)

'BELKNAP' CLASS
CG 26 *Belknap* (Norfolk, Va)
CG 27 *Josephus Daniels* (Norfolk, Va)
CG 28 *Wainwright* (Charleston, SC)
CG 29 *Jouett* (San Diego, Ca)
CG 30 *Horne* (San Diego, Ca)
CG 31 *Sterett* (Subic Bay, Rp)
CG 32 *William H. Standley* (San Diego, Ca)
CG 33 *Fox* (Long Beach, Ca)
CG 34 *Biddle* (Norfolk, Va)

'TICONDEROGA' CLASS
CG 47 *Ticonderoga* (Norfolk, Va)

'LONG BEACH' CLASS
CGN 9 *Long Beach* (San Diego, Ca)

'BAINBRIDGE' CLASS
CGN 25 *Bainbridge* (Bremerton, Wa)

'TRUXTUN' CLASS
CGN 35 *Truxtun* (Bremerton, Wa)

'CALIFORNIA' CLASS
CGN 36 *California* (Alamedia, Ca)
CGN 37 *South Carolina* (Norfolk, Va)

'VIRGINIA' CLASS
CGN 38 *Virginia* (Norfolk, Va)
CGN 39 *Texas* (San Diego, Ca)
CGN 40 *Mississippi* (Norfolk, Va)
CGN 41 *Arkansas* (Alameda, Ca)

DESTROYERS

'SPRUANCE' CLASS
DD 963 *Spruance* (Norfolk, Va)
DD 964 *Paul F. Foster* (Long Beach, Ca)
DD 965 *Kinkaid* (San Diego, Ca)
DD 966 *Hewitt* (San Diego, Ca)
DD 967 *Elliot* (San Diego, Ca)
DD 968 *Arthur W. Radford* (Norfolk, Va)
DD 969 *Peterson* (Norfolk, Va)
DD 970 *Caron* (Norfolk, Va)
DD 971 *David R. Ray* (San Diego, Ca)
DD 972 *Oldendorf* (San Diego, Ca)
DD 973 *John Young* (San Diego, Ca)
DD 974 *Comte De Grasse* (Pascagoula, Ms)
DD 975 *O'Brien* (San Diego, Ca)
DD 976 *Merrill* (San Diego, Ca)
DD 977 *Briscoe* (Norfolk, Va)
DD 978 *Stump* (Brooklyn, NY)
DD 979 *Conolly* (Norfolk, Va)
DD 980 *Moosbrugger* (Charleston, SC)
DD 981 *John Hancock* (Charleston, SC)
DD 982 *Nicholson* (Charleston, SC)
DD 983 *John Rodgers* (Charleston, SC)
DD 984 *Leftwich* (San Diego, Ca)
DD 985 *Cushing* (San Diego, Ca)
DD 986 *Harry W. Hill* (San Diego, Ca)
DD 987 *O'Bannon* (Charleston, SC)
DD 988 *Thorn* (Charleston, SC)
DD 989 *Deyo* (Charleston, SC)
DD 990 *Ingersoll* (San Diego, Ca)
DD 991 *Fife* (San Diego, Ca)
DD 992 *Fletcher* (San Diego, Ca)
DD 997 *Hayler* (Norfolk, Va)

'CHARLES F. ADAMS' CLASS
DDG 2 *Charles F. Adams* (Philadelphia, Pa)
DDG 3 *John King* (Norfolk, Va)
DDG 4 *Lawrence* (Norfolk, Va)
DDG 5 *Claude V. Ricketts* (Norfolk, Va)
DDG 6 *Barney* (Norfolk, Va)
DDG 7 *Henry B. Wilson* (San Diego, Ca)
DDG 8 *Lynde McCormick* (San Diego, Ca)
DDG 9 *Towers* (Yokosuka, Japan)
DDG 10 *Sampson* (Mayport, Fl)
DDG 11 *Sellers* (Charleston, SC)
DDG 12 *Robison* (San Diego, Ca)
DDG 13 *Hoel* (Long Beach, Ca)
DDG 14 *Buchanan* (San Diego, Ca)
DDG 15 *Berkeley* (San Diego, Ca)
DDG 16 *Joseph Strauss* (Pearl Harbor, HI)
DDG 17 *Conyngham* (Norfolk, Va)
DDG 18 *Semmes* (Charleston, SC)
DDG 19 *Tattnall* (Mayport, Fl)
DDG 20 *Goldsborough* (Pearl Harbor, HI)
DDG 21 *Cochrane* (Yokosuka, Japan)
DDG 22 *Benjamin Stoddert* (Pearl Harbor, HI)
DDG 23 *Richard E. Byrd* (Norfolk, Va)
DDG 24 *Waddell* (San Diego, Ca)

'FARRAGUT' CLASS
DDG 37 *Farragut* (Philadelphia, Pa)
DDG 38 *Luce* (Mayport, Fl)
DDG 39 *Macdonough* (Charleston, SC)
DDG 40 *Coontz* (Norfolk, Va)
DDG 41 *King* (Norfolk, Va)
DDG 42 *Mahan* (Charleston, SC)
DDG 43 *Dahlgren* (Philadelphia, Pa)
DDG 44 *William V. Pratt* (Charleston, SC)
DDG 45 *Dewey* (Charleston, SC)
DDG 46 *Preble* (Norfolk, Va)

'KIDD' CLASS
DDG 993 *Kidd* (Norfolk, Va)
DDG 994 *Callaghan* (San Diego, Ca)
DDG 995 *Scott* (Norfolk, Va)
DDG 996 *Chandler* (San Diego, Ca)

FRIGATES

'BRONSTEIN' CLASS
FF 1037 *Bronstein* (San Diego, Ca)
FF 1038 *McCloy* (Norfolk, Va)

'GARCIA' CLASS
FF 1040 *Garcia* (Charleston, SC)
FF 1041 *Bradley* (Long Beach, Ca)
FF 1043 *Edward McDonnell* (Mayport, Fl)
FF 1044 *Brumby* (Charleston, SC)
FF 1045 *Davidson* (Pearl Harbor, HI)
FF 1047 *Voge* (Mayport, Fl)
FF 1048 *Sample* (Pearl Harbor, HI)
FF 1049 *Koelsch* (Mayport, Fl)
FF 1050 *Albert David* (San Diego, Ca)
FF 1051 *O'Callahan* (San Diego, Ca)

'KNOX' CLASS
FF 1052 *Knox* (Yokosuka, Japan)
FF 1053 *Roark* (San Diego, Ca)
FF 1055 *Hepburn* (San Diego, Ca)
FF 1056 *Connole* (Newport, RI)
FF 1057 *Rathburne* (Pearl Harbor, HI)
FF 1058 *Meyerkord* (San Diego, Ca)
FF 1059 *W. S. Sims* (Mayport, Fl)
FF 1062 *Whipple* (Pearl Harbor, HI)
FF 1063 *Reasoner* (San Diego, Ca)
FF 1064 *Lockwood* (Yokosuka, Japan)
FF 1065 *Stein* (San Diego, Ca)
FF 1066 *Marvin Shields* (San Diego, Ca)
FF 1067 *Francis Hammond* (Yokosuka, Japan)
FF 1068 *Vreeland* (Mayport, Fl)
FF 1069 *Bagley* (San Diego, Ca)
FF 1070 *Downes* (San Diego, Ca)
FF 1071 *Badger* (Pearl Harbor, HI)
FF 1073 *Robert E. Peary* (Pearl Harbor, HI)
FF 1074 *Harold E. Holt* (Pearl Harbor, HI)
FF 1075 *Trippe* (Charleston, SC)
FF 1076 *Fanning* (San Diego, Ca)
FF 1077 *Ouellet* (Pearl Harbor, HI)
FF 1078 *Joseph Hewes* (Charleston, SC)
FF 1079 *Bowen* (Charleston, SC)
FF 1080 *Paul* (Mayport, Fl)
FF 1081 *Aylwin* (Charleston, SC)
FF 1082 *Elmer Montgomery* (Mayport, Fl)
FF 1083 *Cook* (San Diego, Ca)
FF 1084 *McCandless* (Norfolk, Va)
FF 1085 *Donald B. Beary* (Norfolk, Va)
FF 1086 *Brewton* (Pearl Harbor, HI)
FF 1087 *Kirk* (Yokosuka, Japan)
FF 1088 *Barbey* (Long Beach, Ca)
FF 1089 *Jesse L. Brown* (Charleston, SC)
FF 1090 *Ainsworth* (Charleston, SC)
FF 1092 *Thomas C. Hart* (Norfolk, Va)
FF 1093 *Capodanno* (Newport, RI)
FF 1094 *Pharris* (Norfolk, Va)
FF 1095 *Truett* (Norfolk, Va)
FF 1097 *Moinester* (Norfolk, Va)

'GLOVER' CLASS
FF 1098 *Glover* (Norfolk, Va)

USS* Aylwin, *a 'Knox' class frigate, launches an ASROC missile from its dual-purpose octuple ASROC/ Harpoon missile launcher. ASROC carries a Mk 46 torpedo or a nuclear depth charge as warload.